DOCUMENT RESUME

ED 023 231 40 EC 002 749

By-Wortman, Richard A.

Coaching and Teaching in Retardates: The Raven Matrices as a Learning Situation. Final Report.

Western Reserve Univ., Cleveland, Ohio.
Spons Agency-Office of Education (DHEW), Washington, D.C. Bureau of Research.
Bureau No-BR-6-8441
Pub Date Jan 68
Grant-OEG-3-6-068441-1568
Note-90p.
EDRS Price MF-$0.50 HC-$4.60
Descriptors-Abstract Reasoning, Cognitive Processes, Cognitive Tests, Educable Mentally Handicapped, Environmental Influences, *Exceptional Child Research, Group Norms, *Mentally Handicapped, Nonverbal Ability, Nonverbal Learning, Nonverbal Tests, Problem Solving, Socioeconomic Background, Suburban Youth, Testing, Test Results, Tests, Thought Processes

In order to determine the differential ability of mildly retarded school children to profit from coaching on non-verbal, non-academic reasoning problems and to study their problem solving and conceptual behavior, the Raven Coloured Progressive Matrices Test was given to 72 educable students (IQ 55 to 80) in socioeconomically homogeneous suburban slow learner classes (age 6 to 19). Control groups included 36 noncoached subjects and 21 coached and 19 noncoached normals (IQ 95 to 105). Encouragement was given during three test sessions after a coaching session on similar problems; controls were exposed to practice materials without coaching. Interaction of coaching with mental age helped to produce gains in the experimental group, who gained more and faster than the noncoached, with the first gain being the greatest. Significant gains (p=.05) were recorded for age groups 8 to 9, 12 to 13, and 14 to 15, and were on coaching for the designs where the strong lines were oblique. The conclusion was that mild retardates think like normals but are unable to keep pace after age 12 to 13, particularly in analogical reasoning (corresponding with Piagetian distinctions between concrete and formal thought operations, appearing at age 12). Nongainers had significantly greater physical, emotional, and cultural pathology (p=.05) than gainers. (Author/SN)

Max E. Thudder BR-6-8441 PA40

FINAL REPORT

PA 40

Project No. 6-8441

Grant No. OEG 3-6-068441-1568

COACHING AND TEACHING IN RETARDATES:

The Raven Matrices as a Learning Situation

January 1968

ED023231

U.S. DEPARTMENT OF

HEALTH, EDUCATION, AND WELFARE

Office of Education

Bureau of Research

EC002 749

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL OFFICE OF EDUCATION POSITION OR POLICY.

FINAL REPORT

COACHING AND TEACHING IN RETARDATES:

The Raven Matrices as a Learning Situation

Project No. 6-8441

Grant No. OEG 3-6-068441-1568

Richard A. Wortman, Ph.D.

January, 1968

The research reported herein was performed pursuant to a grant with the Office of Education, U.S. Department of Health, Education, and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official Office of Education position or policy.

Western Reserve University
Cleveland, Ohio

ACKNOWLEDGMENTS

The author is grateful for the monetary support provided by the Office of Education. This work was begun at the Mental Development Center, Western Reserve University, and completed at the Psychiatry Department, University Hospitals, and the Medical School of Western Reserve. The author is most appreciative of the freedom and time afforded by these institutions for the project. The assistance of a number of colleagues, who know who they are, has been greatly appreciated. Especially to be thanked are the many students, teachers, specialists and administrators of the school system concerned, who were so generous with their time and efforts.

For the "Behavior Checklist" thanks are due to the Bellefaire School.

The expert services of C.J. Meliska, who did the analyses of variance, were greatly appreciated.

Table of Contents

	Page
Acknowledgments	ii
Introduction	1
Problem	1
Related Research	2
Objectives	4
Method	5
Results	7
Discussion	18
Conclusion	23
Summary	26
References	29

Appendix:

- A Coaching Techniques
- B Coaching Effect
- C Raven Test Gains Due to Coaching Above Control
- D Mental Ages: Coached vs. Non-coached
- E Mean Raven Scores for Coached and Uncoached Groups Over Four Administrations
- F Distribution of Coached Ss on Σ D
- G Raven Guided Interview
- H Raven Behavior Checklist
- I Rating Scale for Historical Data
- J Gainers vs. Losers on Σ H Score
- K Capsule Backgrounds of Extreme Gainers and Losers
- L Mean Raven Scores for Normals - Coached and Non-coached Groups
- M The Raven Matrices

INTRODUCTION

Problem

When diagnosing learning problems in mentally handicapped children, planning their education, and attempting to predict their future adjustment, a major objective is to assess the child's ability to learn. It has become apparent that standardized tests of intelligence, despite their many values, possess deficiencies in this assessment role. These deficiencies are due principally to the contribution of variegated environmental influences to the development of a child's measured "intelligence" (11) and our inability to make accurate allowances for these influences. Therefore, judgments of ability to learn are usually based on highly verbal examinations of "old learning", acquired under uncontrolled and largely unknown conditions, with the result that retardates of like IQ turn out in practice to have widely differing abilities to profit from experience and instruction.

When ability to learn is at issue, the child's performance in a learning situation might better be studied directly, and a direct effort be made to assess his ability to profit from instruction on novel non-verbal material. In this way response to instruction is sampled directly, and differential abilities to verbalize do not play such a large role in the evaluation. Therefore, an assessment of ability to learn is made which may be more useful than the unadorned IQ has been found to be for the purposes of educational planning and life adjustment help for intellectually handicapped children.

This research attempts to discover mildly retarded elementary school children of substantially identical IQ who differ appreciably in their ability to take advantage of coaching on a non-verbal, non-academic reasoning task, the Raven Coloured Progressive Matrices. If mildly retarded children of the same intellectual level profit differentially from standardized instruction on analogs of this popular series of non-verbal reasoning problems, (i.e. coaching),

then we have a means of assessing learning ability in a miniature instructional situation. This not only gives us another estimate of learning ability as a research tool, but one which may lead to keener diagnosis, and to more accurate prognosis of school performance and adjustment in later life.

Assuming that the technique proposed demonstrates that these children (1) gain more from coaching on examples of reasoning problems than they would from simply being exposed to those problems repeatedly, and (2) that these gains are quite heterogeneous (that is, that some children of like IQ gain appreciably more than others), another issue comes to the fore; namely, what may be the reasons for these differential abilities to learn? Of the many possible related variables, this research investigates several features of family background and of observed personality traits.

Since Piagetian investigations of different stages and forms of children's thinking have become better known in America, students have been increasingly interested in developmental aspects of problem solving and concept formation. However, direct studies of the problem solving of retardates are still rare in the literature. A secondary objective of this research is to relate differential ability to learn from coaching to success on the several types of reasoning problems comprising the Raven test, namely identities, gestalt completions and analogies. This is intended to be a contribution to the analysis of thinking problems of retardates.

Even a single administration of the Raven test would appear to be potentially useful as a non-verbal, relatively "culture free" means of assessing children's reasoning powers in the early school years. However, normative data for mildly retarded subjects of different ages is missing from the Raven literature. This study supplies such a normative distribution, and thereby increases the usefulness of this test for educational screening.

Related Research

It is becoming well known that retardates who are relatively homogeneous in having low IQs and a history of school failure nevertheless differ considerably in their ability to learn, especially on non-verbal, non-academic materials. Such a difference is

often apparently crucial for their ability to profit from school and to manage practical affairs in later life. For example, the well known longitudinal study of Baller, Charles and Miller (15), examining later life adjustment of persons classified mentally deficient in elementary school, points out the surprisingly large proportion of these persons who were able to live independently in the community as adults. A number of studies show that retardates overlap normal and even gifted group performances of some mental functions (e.g. 9, 17, 7), especially if the material is more 'ikonic' (diagrams) than 'symbolic' (numbers and words), to use Bruner's terms. Budoff (1) has extended his research on coaching adolescent retardates to show that those of his subjects who profited from coaching on Kohs Blocks were appreciably better than those who did not on such tasks as paired associates and double alternation, rigidity and concept-switching measures, and on Raven and WISC Performance scores (see his papers presented at 1965 APA, AAMD and SRCD meetings). Arrived at earlier, such a differentiation between those who "gain" in a sample instructional situation and those who do not could lead to more effective remedial intervention, as well as permit more useful prognostic statements about these children.

It also seems important to study personality and background variables of mentally handicapped youngsters in relation to their ability to learn, particularly because there is no reason to suppose retardates suffer less than do "normals" from cultural deprivation and other numbing environmental influences which have been so amply documented recently by Hunt (8), Deutsch (5) and others, and which subvert the development of verbal-academic skill, as well as our customary ways of detecting mental efficiency. A good deal of clinical and cross-sectional evidence also shows the heavy effect upon learning and motivation of emotional difficulties and character traits (e.g. 3, 18) and there is ample reason to suppose these influences are even more powerful in the retarded population than in normals (e.g. 4, 19).

As Rosenberg notes (in 6), there are in the literature comparatively few papers investigating reasoning in mentally retarded subjects. The Raven test consists of non-verbal reasoning problems of several different types and of increasing difficulty. These types might be labeled identities (in which a well established form has to be duplicated), gestalts (in which an established trend has to be completed to arrive at a balanced form), and analogies (in which

a principle of relationship has to be abstracted and followed to complete the design properly.) Recent investigations have begun to establish, with concrete Piagetian materials, the types of reasoning which can be expected from children of different ages and mental abilities. For example, several studies reveal that such simple analogies as those involving relative lengths (transitivity of length), which are possible for most normal children at age 8, cannot be performed by mild retardates until about age 13 (e.g. 12, 20). Much more empirical work remains to be done, however, before there will be available sufficient data from which to fashion a principled understanding of deficient reasoning in retarded persons. The study will relate the ages of the subjects, their ability to profit from coaching, and some of their background and personality features to success and failure on the several types of reasoning problems comprising the Raven test.

Among the various tests employed in studies of reasoning performance, the Raven Coloured Progressive Matrices Test has a number of features which recommend it for the proposed research and for early educational assessment. It is attractive to young children, easily administered, and short enough to sustain concentration and attention in the young, while long enough to provide satisfactory reliability. It correlates as highly with the Binet and WISC as these two tests do with each other. The Board and Book forms are considered comparable (10). There is readily available in Burke (2) and in Buros' Mental Measurements Yearbooks a sizable literature on the test. As is mentioned above, Budoff's work with adolescent retardates indicates those subjects who gain from coaching on Kohs Blocks perform best on the Raven also. Burke also urges gathering of normative data for special groups. This study provides normative data for suburban mentally retarded children. At present only one study gives data for a retarded group on the revised (1956) Raven Coloured Matrices (13). Many of these children were institutionalized, and only group mean scores are presented irrespective of age.

Objectives

(1) To determine differential ability of mildly retarded school children, ages 6-19, to profit from coaching on non-verbal, non-academic reasoning problems. This requires determining (a) if coaching has any effect on performance beyond that of repeated

exposure to the problems, and(b)if within the coached group there is an appreciable distribution in ability to profit from the coaching; in other words, do some children gain in ability to do these problems by reason of coaching considerably more than they would be expected to just on the basis of a "practice effect." Such a group may be called "gainers", in contrast to "non-gainers", who do not so gain in ability to do the problems after coaching. This distinction is the same as that made by Budoff and Friedman (1).

(2) To study background and personality traits possibly related to learning potential, mainly by comparing them to the gainer vs. non-gainer distinction. Structured interviews regarding the teacher's knowledge of the child and his family, and ratings by the teacher of the child's behavior and personality, are used to rate physical, emotional and cultural factors in the child's background considered detrimental to his learning potential.

(3) To study problem solving and conceptual behavior of mildly retarded children on non-verbal, non-academic reasoning tasks of distinct type, namely identities, gestalt completions and analogies. These types of problems are described under "Related Research" above. Success and errors on these problem types will be related to age of subject, gainer vs. non-gainer distinction, and background and personality variables, in an effort to relate limitations placed on the reasoning efforts of mildly retarded children to these factors.

(4) To secure normative data for suburban mildly retarded children on the Raven Coloured Progressive Matrices Test (1956). *This will include raw score distributions,* distributions of practice effects, and data from comparison samples of peers.

Method

The principal subjects were educable (mildly retarded; IQ 55-80) students in the slow learner classes of a large suburban public school system. Family socio-economic status level among the Ss was quite homogeneous, the median being level 5 of Hamburger's rating scale (21), mostly skilled factory workers, higher level clerks, and the like. Of the 247 potential Ss in this pool, 236 were given an initial Raven. Four parents refused to let their children be seen, and seven children were absent or ill during the initial testing period. To comprise the main experimental (coached) group, 72 Ss were selected, 12 in each of six age groups: 6-7,

8-9, 10-11, 12-13, 14-15, and 16-19. Within these groups a rough attempt was made to represent the range of IQ and initial Raven scores, and to balance sex representation. A control (non-coached) group was similarly selected, consisting of 36 Ss, six per age group. Ss with signs of extreme neurological or severe emotional pathology were eliminated from the study. In addition a normal contrast group of 40 Ss aged 7-11 was selected from those students having IQs on standardized group testing in the 90-110 range. Almost all of the final normal group had IQs of 95-105; 21 of these Ss comprised a coached sub-group, and 19 a non-coached sub-group.

Approximately four weeks after initial testing the experimental group was coached on a problem series consisting of tasks constructed on the same principles as the designs in the Raven. The control group was asked to solve the same series without coaching. Both groups were then retested immediately with the standard Raven series. A third and fourth testing with that series followed at intervals of about one school week (4 or 5 days). An experimental oversight resulted in a deviation in inter-trial interval which should be noted. Sixteen non-coached Ss in the 6-11 year group, and one in the 12-19 year group had intervals between Raven I and II of a week or less, instead of the four weeks which was true for the other Ss. In the contrast group of normal Ss, all inter-trial intervals were 5 to 7 days, with the exception of three instances of 4, 8 and 9 days.

For all Ss the test series was administered with much support. This means that encouragement was offered, praise given both for right answers and hard tries, and even direction of attention used with younger Ss; that is, if their attention wandered or they reverted to guessing, or perseverated position responses, they were briefly urged to "look up top first, and see what piece you need; then look over all the pieces down below carefully before you pick one out." Careless, rushing Ss were urged to take their time. Supportive acknowledgements of struggle were given as seemed helpful to sustain effort (e.g., "It is hard, isn't it, but do your best").

The coaching series consisted of ten designs similar to those in the Raven test series; three of the simpler "Identity" type, four of the more difficult "Gestalt" type, and three of the most difficult "Analogy" type. Five of these ten were presented to each experimental subject in order of difficulty, commencing with a design

similar to the one the S had begun to have trouble with on the first Raven administration. The ten designs and the coaching technique are described more fully in Appendix A. Non-coached (control) Ss solved five similarly selected designs under the usual supportive directions before taking the Raven test series for the second time.

Several kinds of data are collected. For all Ss there is available total number of problems right on each Raven administration, as well as the position of right and wrong answers. The sum of all four Raven scores for each S is calculated, as well as the individual and summed gains of subsequent scores compared with the first score. Each S has an age at first administration, a most current IQ, and a current MA calculated from that IQ. Only 8 of the IQs are not Stanford-Binet's, and only 5 of those are in the experimental groups. Father's occupations are available for all experimental Ss. Teachers completed structured interviews and behavioral checklists concerning personality characteristics and background factors for all coached Ss. This material was rated by the author to yield scores on deleterious physical, emotional and cultural factors in the child's life. These are summed to yield a gross index of harmful influences upon learning efficiency.

Results

(1-a) The analysis of variance reported in Appendix B reveals a significant effect of coaching across three retests. Each retest mean is significantly greater than the previous one. An analysis of variance on the gains at each age above the controls for that age shows that the magnitude of the gains due to coaching varies with the age; children above age 12-13 gain the most, children in the 6-7 and 10-11 age groups gain the least, and children in the 8-9 group are below their controls (Appendix C). Table 1 presents these gains at each age level.

Table 1. Average Sum Gain Per Age Level - C and NC vs. Σ

Age:	6-7	8-9	10-11	12-13	14-15	16-19	Ave. Σ Gain	Ave. Gain Per Admin.
C=72/12	3.58	7.5	10.7	10.5	11.2	10.6	9.00	3.00
NC=36/6	1.8	12.7	8.7	1.0	2.8	4.17	5.27	1.73
Total=108/18	3.0	9.2	10.0	7.3	8.4	8.4	7.70	2.57

There is a small but significant difference of four months in mental age between the coached and control groups, favoring the coached group (Appendix D). The accompanying graph of MA on gains in both coached and control groups shows that MA by itself does not produce gains, since the curve for the non-coached Ss is flat. However, MA interacts with coaching, in that the higher the MA, the more the child profits from coaching. This same interaction is suggested by the significant correlations of MA with the initial gain and with the sum of all gains for the coached Ss (.337 and .249), as opposed to the non-significant figures for the corresponding correlations in the control group (.067 and .074). It is also suggested in coached Ss by MA correlations of .25 with Sum D and .34 with D1.

The size of gains in the coached and control groups is shown in the following table, where D1, D2 and D3 represent successive gains using the initial Raven score as a base.

Table 2. Gains of Coached (C) and Non-coached (NC) Ss

	Mean		Standard Deviation	
	C	NC	C	NC
D1	2.5	0.7	3.5	2.4
D2	2.8	1.8	3.5	3.0
D3	3.7	2.8	3.5	3.2
Sum D	9.0	5.3	9.4	7.5

The graphs of Appendix E show these same differences in the learning curves of coached and non-coached Ss. Gains correlated .62 to .78 among themselves, and .85 to .91 with the sum of gains (Sum D). These reliability figures may be contrasted with these for total Raven score in Table 3, below.

Table 3. Correlations of $D_1, D_2, D_3, \Sigma D$ and Successive Raven

				Totals							
	D_1 D_2	D_1 D_3	D_2 D_3	D_1 Σ D	D_2 Σ D	R_1 R_2	R_1 R_3	R_1 R_4	R_2 R_4	R_1 Σ R	R_2 Σ R
C	.785	.632	.670	.903	.916	.871	.849	.845	.907	.930	.974
NC	.626	.531	.738	.798	.914	.917	.868	.853	.881	.950	.968

Returning to the analysis of gains, Table 4 shows the partial gains achieved after each successive Raven administration. Except

Table 4. Partial Gains

No. 2 Administration (D_1), C vs. NC vs. Σ Gain Thru Age Levels

	Age: 6-7	8-9	10-11	12-13	14-15	16-19	$\bar{X}$
C	.083	1.83	2.75	3.08	3.08	4.16	2.50
NC	-.0667	2.50	1.00	-.017	0.83	1.00	0.75
Σ	-.17	2.05	2.17	2.00	2.33	3.11	1.92

No. 3 Administration, (D_2), C vs. NC vs. Σ Gain Thru Age Levels

	Age: 6-7	8-9	10-11	12-13	14-15	16-19	$\bar{X}$
C	.412	2.7	3.67	3.67	3.75	2.9	2.85
NC	1.00	4.33	3.66	0.333	0.667	0.667	1.78
Σ	.61	3.22	3.67	2.56	2.67	2.17	2.49

No. 4 Administration (D_3), C vs. NC vs. Σ Gain per Age Level

	Age: 6-7	8-9	10-11	12-13	14-15	16-19	$\bar{X}$
C	3.08	3.00	4.25	3.75	4.33	3.50	3.65
NC	1.5	5.83	4.00	.83	1.33	2.50	2.67
Σ	2.56	3.94	4.17	2.78	3.30	3.17	3.32

for the 8-9 year age group, coached Ss run consistently ahead of non-coached Ss. Tables 5 and 6 show coached Ss well ahead of non-coached in the proportion of net and sum gains achieved after successive administrations. Table 3 above reveals the same advantage for coached Ss in terms of correlations of interim with final measures of gain, as well as of total Raven score.

(1-b) Tables 1 and 2, above, and the graph of Sum D values in Appendix F, give a picture of the distribution of gains in coached Ss. Their range was considered sufficient to permit the selection of a "gainer" and "loser" group within the 72 coached Ss. Within each age level the number of Ss was determined lying above and below (1) the non-coached Sum D (practice effect), (2) both the coached average and the NC Sum D, and (3) the coached median. Two-thirds of the Ss lay above the practice effect level, and one-half above the coached mean and median. It was therefore decided to let the top one-third at each age be the "gainers" and the bottom one-third the "losers." Since the Sum D distribution appeared to have some natural divisions, two more such groups were broken out, the upper one "extreme gainers" and the lower "extreme losers." Both sets of gainers and losers are analyzed in the next section, with respect to IQ, MA, and ratings of background factors.

(2) The investigator interviewed the teacher of each coached S, and of a number of the control Ss as well, using the "Raven Guided Interview" form shown in Appendix G. These interviews each took from one-half to three-quarters of an hour. The teacher also filled out for each child a "Raven Behavior Checklist", shown in Appendix H. Several months later the investigator reviewed the interview and checklist for each child, and rated the data by the scheme in Appendix I, making full use of his clinical experience, and of his own clinical impression of each child. Ratings for the three areas of "Physical Influences", "Home: Developmental-Emotional Influences", and "Home: Cultural Level and Influences" were summed to yield a "History Index", referred to as Sum Hx. The higher this number, the worse the child's history and current condition were judged to be.

Raven scores are negatively but not significantly correlated with Sum Hx and its part scores. However, correlation of Sum Raven score with Sum Hx for coached Ss (-.2456) is significant ($p < .05$). Some gain scores are significantly

Table 5. Proportion of Net Gain (D_3) Accomplished by D_1 and D_2

	D_1	D_2	D_3
C	2.50	2.85	3.65
Proportion D_3	.685	.780	1.00
NC	.75	1.78	2.67
Proportion D_3	.280	.667	1.00

Table 6. Proportion of Sum Gain Accomplished by D_1, D_2, ΣD and D_3

	D_1	D_1 and D_2	$D_1, D_2, \Sigma D$ and D_3
C	2.50	5.35	9.0
Proportion ΣD	.277	.594	1.00
NC	.75	2.53	5.19
Proportion ΣD	.144	.487	1.00

negatively correlated with Sum Hx and part scores, especially D_2 with Sum Hx (-30).

An analysis of variance was performed using Sum Hx as the dependent measure, and MA, CA, and degree of gain (high, middle and low) as the tested effects, four ranks of MA being matched within age and gain groups. Only the age effect was significant, i.e. older children had lower Sum Hx scores. However, removing the middle third of gainers produced the analysis in Appendix J , which shows that gainers are significantly lower than losers on Sum Hx, again that older children are lower than younger children, and that there is a gainer-loser/MA interaction; that is, Sum Hx decreases with increasing MA for gainers, but increases with increasing MA for losers.

Table 7 summarizes the differences between gainers and losers, so defined, in gain, intellectual and background factors.

Table 7. Gainers vs. Losers, Top and Bottom Third of Coached Group

	N	Mean ∛ Gain	Mean IQ	Mean MA	Mean Phys.	Mean Emot.	Mean Cult.	Mean ∛ Hx
Gainers	24	18.25	73.33	8.60	.512	1.141	1.175	2.863
Losers	24	-.08	70.75	8.31	.704	1.687	1.196	3.625
Diff.(G-L)		18.83	2.58	.29	-.192	-.546	-.021	-.762
t Test		p<.001 Sig.	NS	NS	NS	NS	NS	p <.05 Sig.

When extreme gainers and losers, as defined in (1-b) above, are similarly analyzed, the results in Table 8 below are produced. It will be seen that losers have significantly "worse" background indices than gainers, the rating of developmental-emotional home influences being the significant contributor thereto. The nearly significant tendency for the gainers to be older than the losers should be noted, as should the nearly significant tendency for losers to have a higher proportion of females.

The capsule descriptions in Appendix K give a flavor of the children comprising the extreme gainer and loser groups. One notes particularly the impression of family pathology too great to be borne in the loser group, far more than in the

Table 8. Extreme Gainers and Losers

	N	Mean Sum Gain	Mean Age	Mean IQ	Mean M.A.	Mean Phys.	Mean Emot.	Mean Cult.	Mean Sum Hx
Extreme Gainers	13 M=10 F = 3	23.92	13.54	71.85	9.37	.45	1.04	.99	2.51
Extreme Losers	7 M= 2 F = 5	-6.86	10.74	72.29	8.31	1.04	2.07	1.13	4.28
Diff. G - L	On sex Prop.	30.78	2.80	-.44	1.06	-.59	-1.03	-.14	-1.77
t test or Fisher p.	NS $> .05$	Sig. $< .01$	NS $> .05 < .1$	NS $> .1$	NS $> .05$	NS $> .1$	Sig. $< .05$	NS $< .1$	Sig. $< .05$

gainers. Several children impress as not retardates, but in the average range of intelligence with serious functional impairment from emotional pathology, e.g. #26, #71, #6, #27.

(3) Problem difficulty for retarded Ss, in terms of number of Ss passing, was determined after the first and, cumulatively, after the fourth administration of the Raven. The problem difficulty rankings thus achieved were correlated with the 50% pass order ranking in the Raven manual (p. 33). The resulting rank-difference correlations were .968 for the first administration, and .972 for the sum of administrations.

Table 9 arranges the problems in order of increasing difficulty, as shown by the number of Ss out of 18 at each age level who passed the problem. The extremely hard and extremely easy problems at each age are omitted. If for the 50% difficulty items, presumably the most discriminating at each age level (8 or 9 Ss passing), one compares the age at which Raven's normals passed the same item, one finds an increasing discrepancy between his normal Ss and our retarded Ss as age increases. That is, up until about age 10-12, the most discriminating items are alike for retardates and normals. After that time, retardates find difficult, and therefore discriminating, items which are crucial for normals at much earlier ages. For example, retarded Ss 16-19 find items at 50% difficulty which were so for normals of 10-12. It is of interest that most of these items (e.g. B6, Ab8, Ab11) contain strong diagonal lines.

In view of the above result, several problem pairs were contrasted in terms of successes and failures for the same retarded Ss. The purpose was to see the effect of presenting essentially the same reasoning problem in diagonal or oblique forms, rather than in circular or rectilinear forms. As a contrast pair, the results of the same Ss were compared on Ab5 and B4, two circular figures. By McNemar's chi square test of significance of change, results of the same Ss were not different on the two designs ($p > .40$). Then several diagonal designs were compared with the circular "target" design Ab5. Against Ab11, Ab5 was far easier (chi square 29.+, $p < .0005$), though Ab5 is simply a diamond shaped target. Against Ab6, an oblique ellipse, Ab5 was again far easier (chi square 4.3+, $p < .025$). Against Ab8, a half circle, half diamond design, Ab5 was again far easier (chi square 17+, $p < .0005$). That this difficulty may not be a matter of

Table 9. Problem Difficulty

Age	N of 18 Passing Item										
	14	13	12	11	10	9	8	7	6	5	4
6-7	A5		A6	Ab2 Ab3			B3	A9 B2 A8 Ab5	Ab10	B8 A7	Ab9 B4 Ab4 B6
8-9	A6		Ab3 B3	B2	A9 Ab4	A7 Ab5	A8	A10 Ab7 B4 B6	Ab6 B5	Ab11 B8	Ab9
10-11	Ab4 B2		A8 A10 Ab5 Ab7	A7 A9 Ab6 B5			B6	Ab10 Ab11	Ab8	Ab9	A12 Ab12 B7
12-13		A8 A9	B5	A10	Ab10 Ab11	B6	Ab8	B7	Ab9		
14-15	Ab4 Ab5 Ab7	Ab6	A8 Ab10	A10 Ab8 Ab11 B5	Ab9		A11 B6		B10	B7 B8	A12
16-19	A9	Ab6 B5	A8 A10 Ab8	Ab Ab10			A11 Ab11 B6	A12		B9 B10	Ab12

diagonal lines alone, however, is suggested by the comparison of Ab5 and Ab4 (a square design) with B5, which is half circle, half square. For Ab4 vs. B5, chi square was 9+, $p < .005$, showing Ab4 to be easier, and Ab5 vs. B5 was about the same.

In an effort to discern what aspects of the Raven identity, gestalt and analogy designs were crucial at different ages, Table 9 was inspected by arranging copies of the designs on a wall to conform to the table. It was seen at once that the three main types of problems overlapped considerably; i.e. some of the fairly homogeneous patterns were harder than some gestalts, and some analogies were easier than some gestalts. (Raven's 50% difficulty calculations for normals, p. 33 of his manual, show the same.) It can also easily be seen by this method that there is a general sweep from upper right to lower left for problems, that is from difficult to easy, though there are a few departures from this trend which suggest (1) mild unreliability and (2) little growth in the ability to do certain problems, particularly analogies, in our retarded Ss after 12 years of age. Attempting to describe salient aspects of discriminating reasoning problems at each age level in a few words, the following might be said:

6-7 year olds

The chief requirement of the problems in the discriminating range is an appreciation of small differences in relatively homogeneous patterns. Ss at this age are just starting to grasp the general requirement for symmetry, the gestalts of common forms like circle and square, and the idea of patterns changing in a principled way.

8-9 year olds

Ss at this age have a firmer grasp of small cues, and can make finer discriminations. They are better with symmetry, even of less common gestalts. They grasp some simple analogies, but only those which have strong gestalt properties, such as B6.

10-11 year olds

Tough pattern discriminations containing confusing figure-ground changes are grasped. Even simple gestalts using oblique and diagonal lines are fairly easy. Except for the very best Ss, analogies still need gestalt properties to be solved.

12-13 year olds and up

As previously stated, general improvement in the ability to do Raven problems slows down considerably in our older Ss. Therefore they will be discussed as a group. Find discriminations of changes in homogeneous designs with figure ground difficulties still figure at the "easy" end of the table (i.e. the left hand side). Strong gestalts, such as Ab4, 5 and 7, are no longer discriminating by 16-19. Oblique and irregular gestalts (B5, Ab6) still figure, about as much as those requiring very fine discrimination of changes, mentioned above. Analogies with strong gestalt properties, such as Ab8 and Ab9, continue to become easier in this age period, though B7, a simple analogy with strong diagonal gestalt properties, remains most difficult. Also remaining fairly hard are gestalts and analogies with strong diagonal lines such as Ab11 and B6. Still very hard are problems requiring the extrapolation of irregular patterns (e.g. A11, A12), as well as analogies without gestalt cues in which two changes take place at once (B8, B10). In general, most of the Ss never get beyond solving gestalts or pattern extrapolation like A12 which contain strong cues in the visible part of the pattern.

An attempt was made to investigate differences between coached and non-coached Ss within age groups on the most discriminating problems for those ages. As will be brought out in the discussion, a paucity of Ss obscured most of the possible comparisons. However, those problems which had C vs. NC splits on success of 10:2 or greater (recall there were 12 C and 6 NC Ss at each age level) were the following, all C > NC except the first.

6-7	A9 (NC > C), Ab3, B3
8-9	Ab6 (sig., $p < .05$)
10-11	Ab10
12-13	B6 (sig., $p < .05$)
14-15	B10
	B6 (sig., $p < .05$)
16-19	None

Tested by Fisher's exact test, only three show a significant advantage to the coached Ss. Still it is interesting to note that in four instances of these large differences, the strong lines of the design are oblique. B10 and Ab10 have the right choice in the "easy" #3 position, that is directly beneath the omitted portion of the pattern.

Again attempting to assess the effect of coaching on individual problem solution, all the problems were ranked for number of Ss succeeding at the fourth Raven administration, within C and NC groups. The rankings were very similar. The largest advantage for coached Ss was with problems B3 and Ab7, both of which have strong diagonal symmetry. However, NC Ss had an equal advantage, in terms of ranks at least, on A11 and A12, which require extrapolation of changing patterns, and are harder than B3 and Ab7.

(4) Figure 1 gives a distribution of educable children on the initial administration of the Raven. Medians are drawn or estimated from the tables for normal children in Sperazzo and Wilkins (16). Medians for our three age groups of local normal children are also noted.

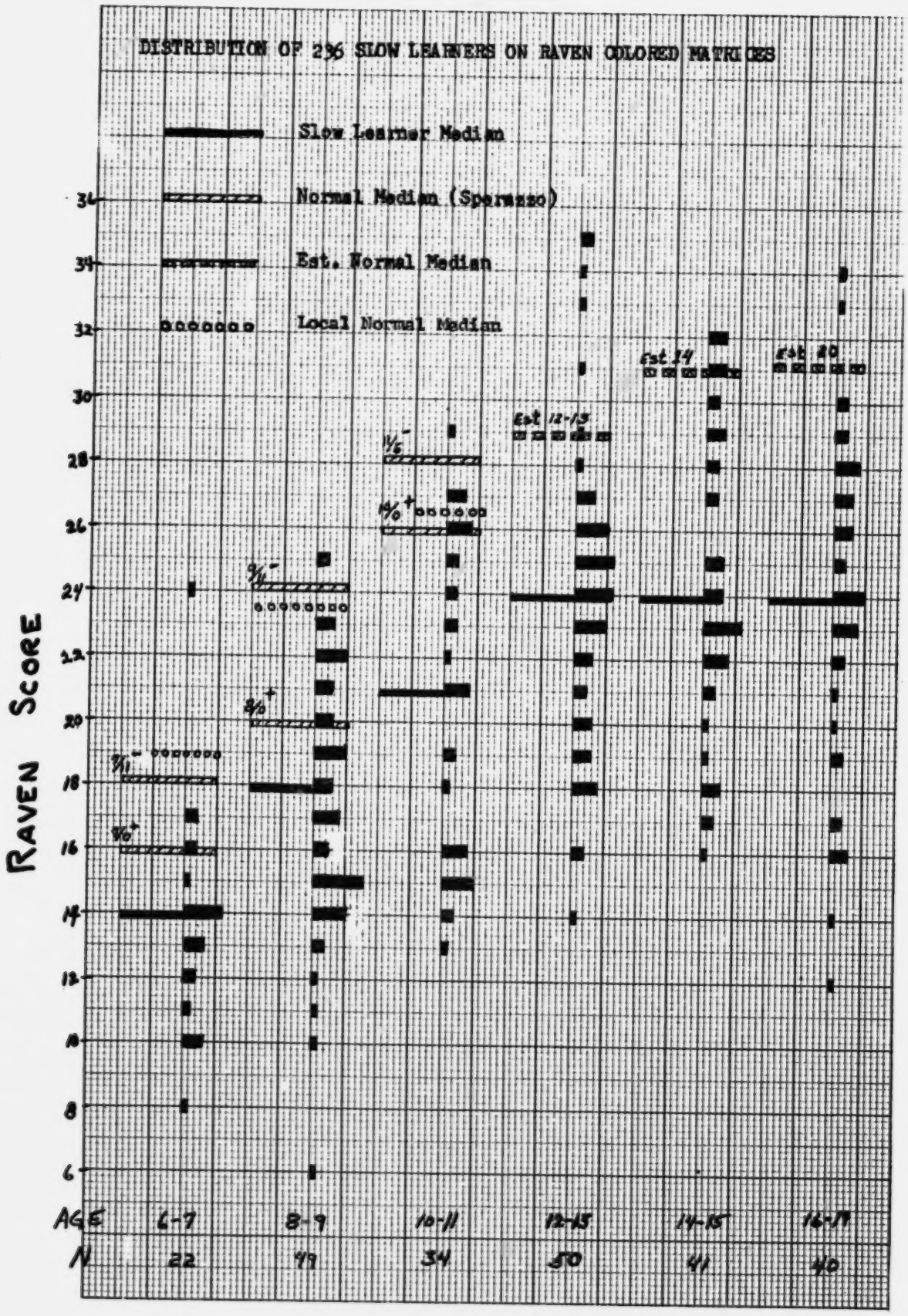
Appendix E gives the learning curves through four administrations for our coached and non-coached educable Ss. Appendix L gives the same for their normal peers.

Discussion

(1-a) The effect of coaching is appreciable, and generally increases with age, though the effect is small at 6-7, and reversed at 8-9. This result demonstrates that retardates of the same age and intellectual ability differ considerably in the ability to learn when instructed on novel non-verbal reasoning problems, and that this ability to profit from coaching beyond a practice effect is greatest in the teens (i.e. in junior high school). An interaction with MA is demonstrated within the coached group which is absent in the control group, a rather remarkable effect in Ss chosen to be intellectually homogeneous. Since increased chronological age also means increased mental age, we might say that if one is smarter, older, and taught (it should be remembered the instruction was minimal, but individual), one does better than if he is duller, younger, and just "practices." While this is hardly startling as a general statement, recall that at least two-thirds of our Ss were restricted to the IQ range 62-78. In terms of gain, MA is a powerful factor even in this range, but only when cultivated (coached).

The problem that 6-7 year olds of educable IQ have with sheer ability to attend, and with being overwhelmed by even the kindliest adult, probably accounts for the small effect at that age. The

Figure 1.


DISTRIBUTION OF 286 SLOW LEARNERS ON RAVEN COLORED MATRICES
Slow Learner Median
Normal Median (Speranzo)
Est. Normal Median
Local Normal Median
RAVEN SCORE
AGE
N
6-7
22
8-9
77
10-11
34
12-15
50
14-15
41
16-17
40

reversed effect at 8-9 is felt to be an artifact due to experimental error. This control group was selected from Ss seen in pilot work, when experimental routine had not been finally established. It is suspected these Ss had more time taken with them, under warmly supportive and rather 'instructional' conditions, than did the other control Ss.

The graphs of Appendix E and tables 2, 4, 5 and 6 show that coached Ss not only gain more (achieve more of their potential), but gain faster than do the non-coached. The correlations of Table 3, and the raw gains and proportions of Tables 4, 5 and 6 also suggest that the second Raven score (just post coaching for the C group) is highly representative of the final and the summed Raven scores, and that the first gain is the greatest, and in the coached group most representative of final and summed gain. However, the stability of the gain score by itself leaves something to be desired.

(1-b) The corresponding section in "Results" is self-explanatory. The + - 1 S.D. area for the coached Ss on gain lies between 0 and 18, a gratifying spread to work with as some index of "learning potential." With the modest reliability of the gains, and the unknown reliability of the background rating method, it was thought only a top and bottom cut from the coached gain distribution had a chance of showing relationships with "Sum Hx", the index of background factors deleterious to learning, as indeed was the case.

(2) It is recognized that the rating scheme is not refined, at least in the way of reliability from re-rating, rating by others, and the like. The time not put into these devices was put into a very thorough interview of the teachers, and a consideration of the child's background and status which, lacking the usual extensive examination of the child, his parents and his home, was still as complete and as relevant to learning as the investigator's clinical acumen could make it. The question of rating bias also arises, because the rater had seen the children perform. However, by the time the rating was done, the rater had only a hazy recollection of a few performances of a few of the Ss. Further, if he had any a priori hypothesis it was that the high gainers would have the worst histories, on the theory they were average children who were in slow learner classes because background influences had prevented optimal school performances. Therefore, the attempt

to relate such a background index to an equally tenuous index of "learning potential" was rather a shot in the dark, and the results were a surprise.

The analysis of variance in Appendix J illuminates the negative correlations of Raven and gain scores with Sum Hx. It amounts to saying that the rich get richer and the poor poorer. One is a gainer because his Sum Hx was not bad enough to cancel out his MA advantages; he is a loser if his Sum Hx was bad enough. Note that coaching brought out this effect, due to the interaction of coaching and MA to produce gain, mentioned above. It would not have been revealed in the control group, i.e. by practice. That older Ss have lower Sum Hx is an artifact due to the fact children can cover their upsets better as they get older, and to less information being available to the teacher as the child gets older. Analysis of the extreme gainers and losers also suggests (more speculatively) that, especially when one is dull, feminine, and young, heavy physical, emotional and cultural pathology cannot be borne. The children mentioned who may be only functional retardates are only a few of a sizable group we would put in that category, all of whom were in slow learner classes in a suburban school system, each usually with several IQs less than 80. Parenthetically, it may be mentioned here that the shape and elevation of Raven learning curves appear to be promising indicators of such children with largely emotionally based learning problems rather than "genuine" retardation. However, the several hints of this in pilot work were not further explored in this investigation.

(3) The proposed analysis of successes and errors on individual Raven problems, which must largely be done within age groups because problem difficulty varies greatly over time in the developmental period, runs into trouble because of insufficient N. For example, with 4 gainer and 4 losers attacking a problem, even a 4-0 split on success will not be significant. Again, 5 errors are possible on each problem, but even if most of the 18 Ss at an age level fail the problem, the errors are spread too thinly to make one or two kinds of errors significantly more frequent than the others. The same kind of limitation is placed on divisions in terms of Sum Hx or other background items. Therefore, more Ss will have to be seen before such an analysis can be made. However, some study of problem difficulty and its meaning could be made, and is discussed here.

The high correlations of problem difficulty rankings between out retarded Ss and Raven's normals suggest that, over all ages in the developmental range, and over all these problems, retardates think much like normals. However, comparisons of normals and retardates within age levels on particular problems would be needed to develop this point adequately. The problem analysis which follows begins to approach this task, and finds our Ss unable to keep pace with Raven's normal Ss after 12-13 years of age in development of reasoning, particularly on non-verbal analogies. However, it should be kept in mind that this result is based upon quite a small sample of Ss and problems, and that the indices of item difficulty are not identical. It would be desirable to have larger groups of both retardates and their normal peers to compare at specific ages on these problems. Still, this trend for improvement, in terms of success on harder types of thinking, to slow down after the early teens is supported by the data in the table showing shifting item difficulties for our retarded Ss.

The descriptive analysis of crucial aspects of the problems which discriminate at the several age levels certainly suggests that there is no easy way to categorize what makes a problem difficult. Degrees of difficulty seem compounded not only of obviously disparate conceptual tasks, but also of complexity and perceptual differences, and even of position effects. The effect of rendering essentially the same problem in oblique lines rather than in circular or rectilinear form is striking. Whether this is purely a 'perceptual' difficulty remains in doubt, as does its role in the performance of retardates as opposed to normals. Under "Conclusions" we speculate briefly on these questions.

The comparisons of successes on particular problems, between coached and non-coached groups, suggests that coaching may have helped with some of the symmetrical gestalts, but not with analogies. This would be consistent with our impression, from the table of problem difficulties, of those problems at which retardates find greatest improvement. The NC advantage in terms of ranks for analogy problems is not supported by the actual numbers of successes on the problems.

(4) Figure 1, the slow learner distribution on the Raven, is self-explanatory, as are the appendices giving learning curves for retarded Ss and normals on repeated administrations of the Raven. Their possible utility will be commented on under "Conclusions."

Conclusions, Implications and Recommendations

This section is organized by numbered divisions, parallel with previous sections. The conclusions offered at the beginning of each numbered division are brief extracts of those arrived at in "Results" and "Discussion" sections, to which the reader is referred.

(1) An appreciable effect of coaching on the ability to do non-verbal reasoning problems is demonstrated in our mildly retarded Ss. Interaction with MA helps to produce gains in the coached group, but not in the controls. Coached Ss not only gain more (achieve more of their 'potential') but gain faster than the non-coached. The first gain is the greatest, and in the coached group most representative of total gain. Judged by their inter-correlations, gain scores are not as reliable as the repeat Raven scores from which they are derived, as of course would be expected. Still, they cover a considerable range, especially within the coached group, and therefore merit consideration as indicators of 'learning ability'.

The chief implication of these results is that coaching and repeated administration of the Raven reveals considerable differences in 'learning ability' of retarded Ss. What we get in their gain, which is appreciably greater than they would achieve just by practice, is presumably some indication of what a minimal, benign teaching relationship would do for their achievement. Coaching, a miniature teaching situation,apparently lets the mental age differences work, so to say; given help and a second chance, the retarded child shows more of what he could do than he showed in that anxious encounter when he first met the test and the "teacher".

At the least this result suggests the usefulness of a 20-30 minute investment, to get more than one assessment of learning potential via non-verbal material. Also, two trials is as good as four if coaching intervenes, i.e. if a benign teaching situation is created before the second testing. The low 'reliability' of the gain score, in the sense of inter-gain correlations, is not a good index of the reliability of a child's performance; we should really have his performance on an equivalent form. In any case this 'reliability' figure should not deter one from making use of two Raven scores with intervening coaching, especially if one then refers to the normative learning curve material included herein (Appendixes E and L).

It is felt these results show the promise of the learning situation as an assessment technique, and justify further work with it. Studying the relationship of gains after coaching to achievement or adjustment would be worthwhile. This study did not direct itself to analyzing just what the coaching did, but it is not too much of a speculation to say it probably shows what helpful personal intervention can do for a retarded child's functioning. The possible diagnostic use of Raven learning curves is suggested below.

(2) Within coached retarded Ss, a relationship is demonstrated between known pathology in the child's background and relative inability to gain from coaching. The effect of coaching seems to be to bring out that a child is a gainer because his background rating was not bad enough to cancel out his intellectual advantages (even though these are within the retarded range); one is a loser if his background rating was bad enough. Especially when one is dull, young, and (maybe) feminine, heavy physical, emotional and cultural pathology cannot be borne without further loss of ability to learn. This finding is one of the very few known to the author which specifies the effect of emotional factors upon mildly retarded children in a learning situation (see Kessler, 11, and Webster, 19).

The obvious import of this rather commonsense result is that, for the many millions of mildly retarded children who are on the edge of viability as independent citizens because of their difficulty learning things, relief from the burden of heavy physical, emotional and cultural pathology during early school years is a necessity. Taken seriously, this is a tall order. Not helping to fill it is the feeling of many in teaching and in the helping professions that the child with high potential is the one worth working with. The author may add that the pathology in the homes and backgrounds of many children in this experiment was well up to what he is used to seeing in the histories of referrals to a psychiatric clinic -- and these were "normal" slow learners. Recall again that these children were not from the inner city, but from a "factory worker's suburb" with a good school system.

(3) One outstanding conclusion would be that not enough Ss were used to reveal meaningful subject difference on individual reasoning problems. However, over all ages and problems, superficial comparison appears to show that mild retardates, though they may come to it later, think like normals. A closer view finds our Ss

unable to keep pace with Raven's normal Ss after 12-13 years of age, particularly in analogical reasoning. This statement needs to be squared with an earlier one that teen-aged Ss who were coached gained increasingly, compared to their non-coached peers. In that statement mild retardates were being compared, and the greater gains of the coached Ss came predominately from greater success on problems other than analogies, such as gestalts.

Problem difficulty seemed compounded not only of clearly disparate conceptual tasks, but also of complexity and perceptual differences, and even of position effects. Rendering essentially the same problem with oblique lines makes it much harder. Olson (22) cautions us about looking at this as a "perceptual" problem, pointing out that the ability to see forms seems to be a construction of the child, and as such a conceptual act. This may in part account for the fact that some uncommon combinations of common forms caused almost as much trouble as diagonals to our Ss. Olson succeeded in helping his Ss to achieve these constructions with verbal cues, and coaching may have similarly helped our Ss.

One is certainly tempted to call upon Piagetian concepts to explain the failure of our older Ss with non-verbal analogies. This phenomenon appears to fall neatly in with the distinction Piaget makes between concrete and formal thought operations, the latter involving appreciation of the unseen but hypothetically possible, and emerging about 12 years of age. The ability to abstract and check out possibilities not directly shown is surely the central feature of analogies, and the mental ages of most of our 16-17 year olds was 11-12. Raven himself points out the test was designed to cover the kinds of thinking the child usually develops by 11. Of great interest would be a study which had the same retarded Ss do the Raven problems as well as Piaget's more verbal conservation and transitivity problems, for example. Such a study might well help us to translate results from this non-verbal material to more pedagogically relevant, verbal terms.

Even without such work, however, results of the present investigation support the author's bias that some of the material he has seen offered to the dull child and the slow learner is most unsuitable, namely (a) "New Math" explanations of arithmetical notions using geometric analogies, and (b) practice on verbal analogies as exercises in thinking. Of course, such questions

would have to be studied directly in order to validate these prejudices.

(4) Figure 1 gives a distribution of 236 suburban slow learners on the Raven, normative data which has not been available heretofore. It should increase the usefulness of the Raven as a relatively culture free, non-verbal, non-academic test of intellectual ability, especially so with deaf, non-verbal, and other educationally disadvantaged populations. More mildly retarded Ss are being sought to add to this distribution.

The burden of this report is that the usefulness of the Raven to estimate learning ability can be increased by employing it at least twice, with intervening coaching, as a learning situation. The beginnings of norms and standards for such use are to be found in this report, in the coaching technique of Appendix A, and the retarded and normal learning curves of Appendixes E and L.

The author considers the Raven such a useful instrument, particularly with "special education" populations, that he recommends its re-standardization on U.S. children, with special attention to disadvantaged populations. J. C. Raven would be the appropriate consultant for such an effort. Also recommended is the support of studies of Raven learning curves, with attention to their possible use as a clinical diagnostic device. Some curves, particularly the descending curve, as well as the one which reaches above average for the age, appear to be diagnostically relevant, but require more study.

Summary

Traditionally, educational planning for special students relies heavily on verbal examinations of "old learning", acquired under uncontrolled and largely unknown conditions (i.e., upon intelligence tests). It might be preferable to study the child's learning attempts in an instructional situation with novel materials. This study sought to differentiate mildly retarded school children 6-19 years of age by their ability to learn from coaching on a non-verbal, non-academic reasoning task. The ability to learn, so defined, may be more closely related to their profiting from school and to their management of practical affairs in later life than the IQ has been found to be. Early detection of

these differences in learning ability should facilitate curriculum change and guidance, and make for more accurate prediction of later adjustment.

Several background and personality factors possibly relevant to gaining or not gaining from coaching were examined. The experimental procedure also afforded an opportunity to study attempted solutions of specific types of reasoning problems by retardates of different ages. It also provided normative data, by age and IQ, for an American suburban mildly retarded population on the Raven Coloured Progressive Matrices Test.

Mildly retarded Ss given the Raven were matched and randomly assigned to experimental and control groups. Three test sessions after a coaching session on similar problems (the control Ss were exposed to the practice materials without coaching) determined ability to profit from coaching (i.e. to gain). The highest third of those who significantly gained more than the practice effect ("gainers") were contrasted with non-gainers on background variables and on observations of character traits and working methods. Age and subject differences in the ability to do reasoning problems involving the recognition of identities, gestalts and analogies were examined, in part by comparison with Raven's normal Ss. Learning curves were gathered from retarded and normal Ss, coached and not coached.

Data revealed that coaching interacted with MA to produce gains in the coached group significantly greater than those seen in control Ss. Coached Ss gained more than non-coached with repeated Raven administrations, and gained it faster, Within coached Ss, a relationship was demonstrated between amount of pathology in the child's background and relative inability to gain from coaching. Retarded Ss were unable to keep pace with Raven's normal Ss after 12 years of age, particularly on problems involving analogical reasoning. However, compared to non-coached peers, teen-aged Ss who were coached gained increasingly as they became older. Rendering the same problem with oblique lines made it strikingly harder in a number of instances. A normative distribution for mildly retarded Ss was provided in graphic form.

It was felt these results showed the promise of the learning situation as a means of assessing learning ability. They also revealed directly the heavily detrimental effect upon learning ability of

pathological influences in the life of the mildly retarded child. The difficulty of older educable Ss with analogical reasoning was seen as consonant with Piagetian ideas of the growth of thought operations. The possible relevance of these findings for educational planning was discussed, and recommendations for further studies were made.

REFERENCES

1. Budoff, M. and Friedman, M. "Learning Potential" as an assessment approach to the adolescent mentally retarded. J. Consult. Psychol., 1964, 28, 434-439.

2. Burke, H.R. Raven's Progressive Matrices: A review and critical evaluation. J. genet. Psychol. 1958, 93, 199-228.

3. Buxbaum, E. The parents' role in the etiology of learning disabilities. Psychoanalytic Study of the Child, 1964, XIX.

4. Dalton, J. and Epstein, H. Counseling parents of mildly retarded children. Social Casework, November, 1963.

5. Deutsch, Martin. The role of social class in language development and cognition. Amer. J. Ortho. 1965, 35, 78-88.

6. Ellis, N.R. Handbook of Mental Deficiency, New York, McGraw-Hill, 1963.

7. Heim, A. and Wallace, J. The effects of repeatedly retesting the same group on the same intelligence test. Quart. J. exp. Psychol., 1950, 2, 19-32.

8. Hunt, J. McV. Intelligence and Experience, New York, Ronald Press, 1961.

9. Jensen, A. Learning ability in retarded, average and gifted children. Merrill Palmer Quart., 1963, 9, 123-140.

10. Jordan, T.E. Formboard comparability in the Coloured Progressive Matrices. J. clin. Psychol. 1959, 15, 422-23.

11. Kessler, Jane W. Environmental components of measured intelligence. School Review, 1965, 73, 339-358.

12. Lovell, K. The Growth of Basic Mathematical and Scientific Concepts in Children. London, University of London Press, 1962.

13. Malpass, L.P., Brown, R. and Hake, D. The utility of the progressive matrices (1956) with normal and retarded children. J. clin. Psychol. 1960, 16, 350.

14. McNemar, Q. Psychological Statistics. N.Y. John Wiley & Sons, 1962.

15. Miller, E. L. Ability and social adjustment at midlife of persons earlier judged mentally deficient. Genet. Psych. Monogr. 1965, 72, 139-198.

16. Sperazzo, G. and Wilkins, W.C. Further normative data on the Progressive Matrices. J. Consult. Psychol. 1958, 22, 35-37.

17. Tizard, J., O'Connor, N. and Crawford, J.M. The abilities of adolescent and adult high grade male defectives. J. ment. Sci., 1950, 96, 398-907.

18. Wallach, M.A., Ulrich, D.N. and Grunebaum, M.B. The relationship of family disturbance to cognitive difficulties in a learning problem child. J. consult. Psychol., 1960, 24, 355-360.

19. Webster, T.G. Problems of emotional development in young retarded children. Amer. J. Psychiat. V. 120, July 1963, pp. 37-43.

20. Wortman, R.A. Development of a transitive inference in children. Paper read at March 1965 meeting of Society for Research in Child Development.

Addendum:

21. Hamburger, M. Appendix D in "Realism and consistency in early adolescent aspirations and expectations." Dissertation, Teacher's College, Columbia University, 1958.

22. Olson, D. R. The child's acquisition of the concept of diagonality. Paper presented at SRCD meetings, April, 1967.

Appendix A

Coaching Technique

Four of the ten designs with removable pieces used in coaching are shown in the accompanying illustration, numbered from easiest to hardest. Perhaps an example will best make clear their use with the coached Ss. Assume the S is a 9 year old slow learner who scored 19 on his first Raven administration, missing the last three items in Series A, the last 5 in Series Ab, and the last 9 in Series B. Coaching is started with number 3 of the coaching series, which is the last of the "Identity" items, and continued through number 7, which is the first "Analogy" item.

First S is assured that he did well on the first Raven, but that he is going to be given several chances at it, to see if he can do even better. Before he gets his second chance, however, he and E are going to practice on designs like the ones he did before. There will be five. The easy kind will be skipped, and practice will begin with one like some he had trouble with. E will be teacher, and show him how to do the problems.

Design 3 is produced, and the standard hints are first reiterated: "Remember to look up first, and see what kind of a piece you need; then look down below (pointing) and pick just the right one. Look over all of them before you pick the very best one." Some Ss have a tendency to impulsivity, and they are urged: "Don't let them fool you! Don't jump too fast. Take your time and pick the very best one."

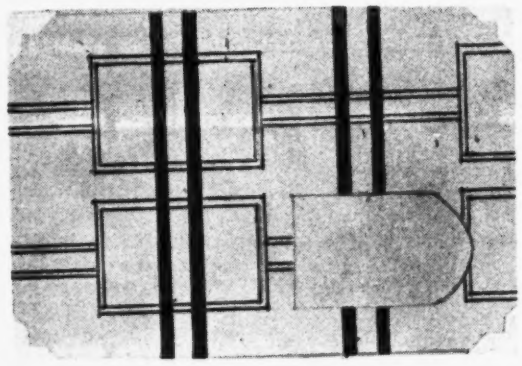
If S makes the right choice at once, he is given praise and E presents design 4. If the wrong choice is made, say choice 4, E says something like "Well, that is close but not quite right." E then removes the wrong piece, and shows S the parallelism involved between the top line and the bottom line, something like this: "The top part and the bottom part have to look alike (tracing left to right with finger). They make them this way so you can figure out what piece goes there. See on the top these little tracks run along, and then they make a big box, and then there are tracks again, and then they start a big box again. Down here the same thing happens. The little tracks start here, then the big box just

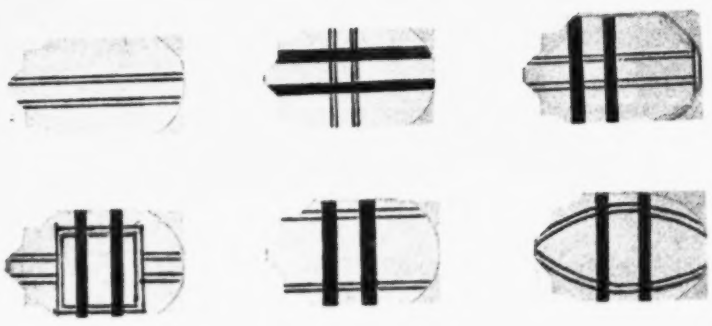
like it was above, then it starts little tracks again, just like above, but here is where they took the piece out. Can you pick the very best piece to go in there now?" If the S picks another wrong piece, or the same one, he is shown just how it is not quite right, and the right one is put in and the parallelism with the top line stressed. If S picks the right piece, the parallel with the top line is stressed before turning to design 4.

Design 4 will exemplify the coaching approach to "Gestalt" designs. E says something like: "This is a little different kind of problem. In this one they are trying to make a picture that is the same on the top as it is on the bottom, and the same on the left as it is on the right. One side balances the other. Look up top first (blocking off the bottom of the design with his hand). This jaggedy think points to this corner, and this jaggedy thing points to this corner. Now look down below. (Blocks out top part.) This rounded thing points to this corner. (E's hands are used in a V to emphasize the line of direction from the center to the corner.) Now what would have to go here (pointing to lower right), a rounded thing or a jaggedy thing?" If S says "A rounded thing," E asks "And which way does it go. Show me the piece that would go there." If S picks a jagged piece, say "No, it would be a rounded thing because up here (blocking bottom off with hand) both pieces are jaggedy, so down here (blocking off top) both have to be rounded. Otherwise it wouldn't look right. Which one would make it look right?" On subsequent "Gestalt" designs the symmetrical and figural aspects of the design are stressed in a similar way. For example, in design 5 E points out that the row of black dots are "going to make something. What are they going to make?" If S doesn't know the answer is supplied and the missing part traced with the finger: "See, it's going to be a square or box."

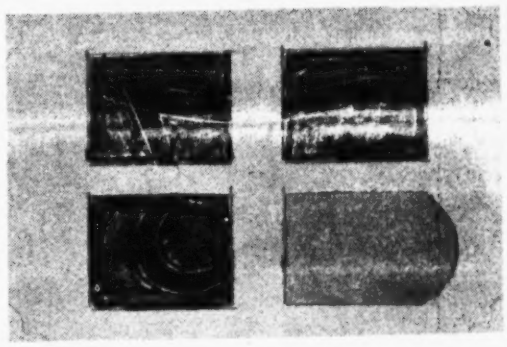
For the "Analogy" designs, of which number 7 is the first example (though it retains strong gestalt properties), E points out that this is a little different kind. "On this one you have to figure out what is happening, what is going on there. There is always some change going on. Up here on top (blocking off bottom part with hand) there are wavy lines in this corner, and they change to black over here. Now down here there are wavy lines in this corner; what will have to be in this corner?" Usually S says black and picks the right piece. If he makes a wrong choice, either of designs or position, the analogical principle is again explained, emphasizing the 'wavy to black' and/or the 'left corner to right corner' change, as required. On this and subsequent designs the "if-then" expression of the pictorial analogy is stressed.

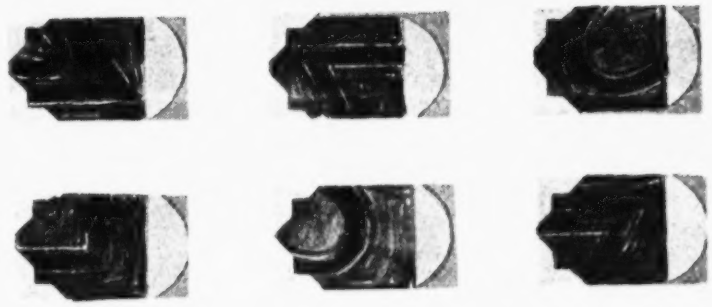
3



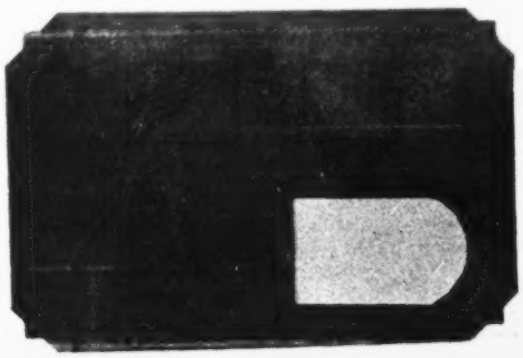


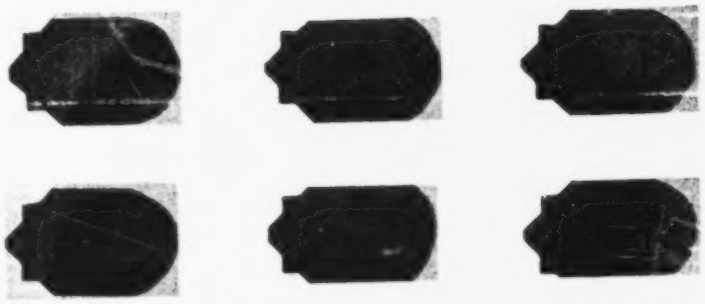
4



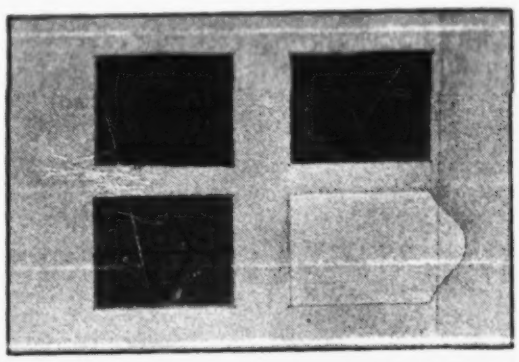


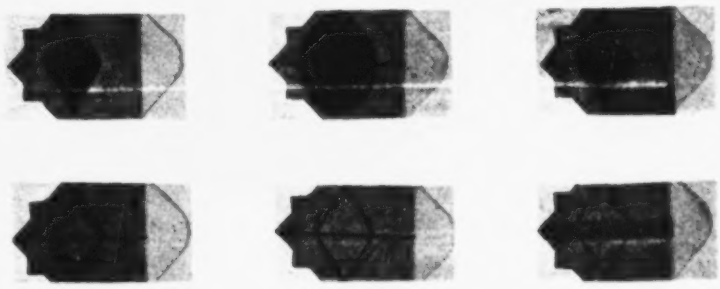
7





8





Appendix B

Coaching Effect

A = Coaching vs. non-coaching — a = 2 (fixed)
B = Age Groups — b = 6 (fixed),
C = Subjects within groups — c = 12 + 6 (random)
D = Replications (retests) — d = 3 (fixed)

Source	SS	df	MS	F	F Crit p < .05	F Crit p < .01	Conclusion
A	112.50	1	112.50	4.59	3.95	6.92	p <.05>.01
B	193.18	5	38.64	1.58	2.30	3.20	NS
AB	195.54	5	39.11	1.59	2.30		NS
C(AB)	2,355.00	96	24.53	-			
D	123.50	2	61.75	17.59	3.04	4.71	p <.001
AD	10.03	2	5.02	1.43	3.04	4.71	NS
BD	54.98	10	5.50	1.57	1.87	2.41	NS
ABD	25.82	10	2.58	1.00	1.87	2.41	NS
CD(AB)	673.67	192	3.51	-			
	3,744.22						

Newman-Keul's Test on Replications (Winer, p. 80 ff)

D means $\frac{1}{1.898} < \frac{2}{2.481} < \frac{3}{3.398}$

Appendix C

Raven Test Gains Due to Coaching Above Control

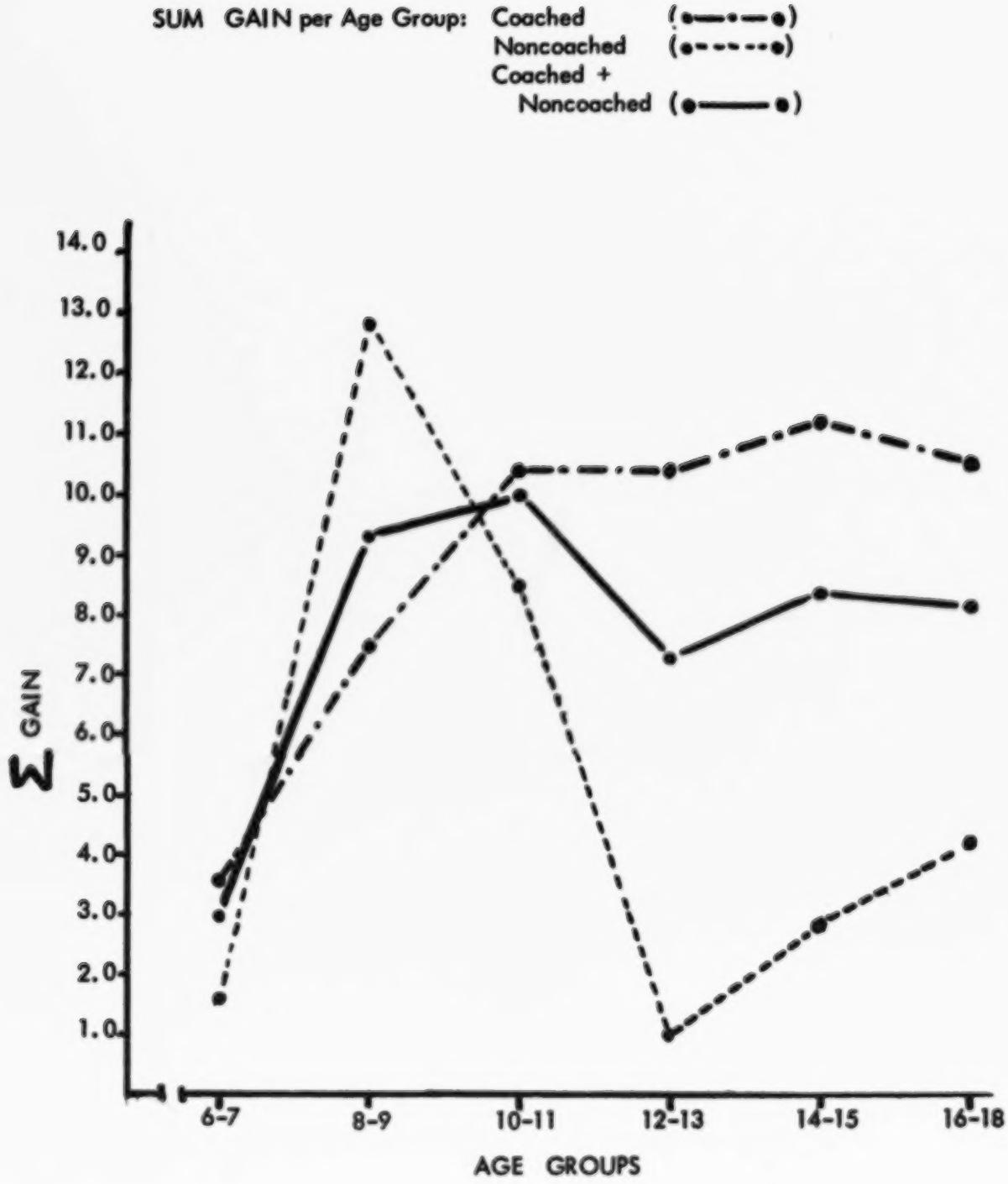
B = Ages
C = Subjects within age groups
D = Replications (retests)

Source	SS	df	MS	F	F crit p<.05	F crit p<.01	Conclusion
B	586.69	5	117.34	4.05	~2.37	~3.34	p<.01
C(B)	1,910.33	66	28.94	-			
D	30.10	2	15.05	4.18	~3.07	~4.79	p<.05>.01
BD	90.34	10	9.03	2.51	1.91	2.47	p<.01
CD(B)	475.70	132	3.60	-			

Newman-Keul's Test on Replications (Winer, p. 80 ff)

$$\underline{B_2} < \underline{B_3B_1} < \underline{B_6B_5} \; B_4$$

	I	II	III
Gains by Ages	8-9	< 10-11, 6-7	< 16-17, 14-15, 12-13


SUM GAIN per Age Group:
Coached
Noncoached
Coached + Noncoached
14.0
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
Σ GAIN
6-7
8-9
10-11
12-13
14-15
16-18
AGE GROUPS

Appendix D

Mental Ages: Coached vs. Non-Coached

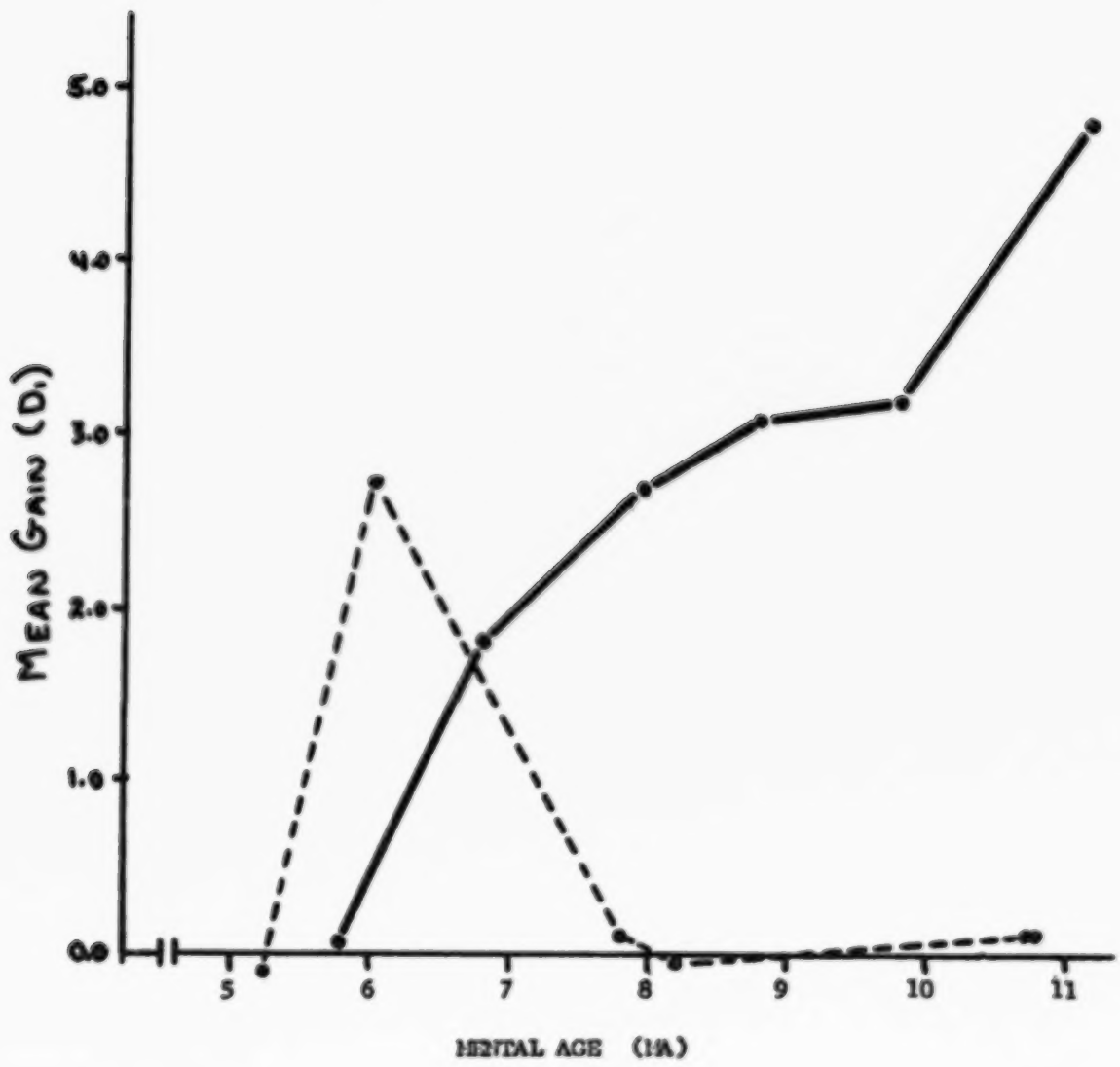
A = Coached vs. Non-coached; a = 2 = fixed
B = Age Groups ; b = 6 = fixed
C = Subjects ; c = 12, 6 random

Source	SS	df	MS	F	F crit p<.05	F crit p<.01	Conclusion
A	355.23	1	355.23	3.23	~2.80	~3.70	p < .05
B	53,077.63	5	10,615.53	96.57	3.92	4.71	p<<.01
AB	1,038.74	5	207.75	1.89	3.92	4.71	NS
C(AB)	10,554.59	96	109.94				
	65,026.19	107					

Table of Average MA

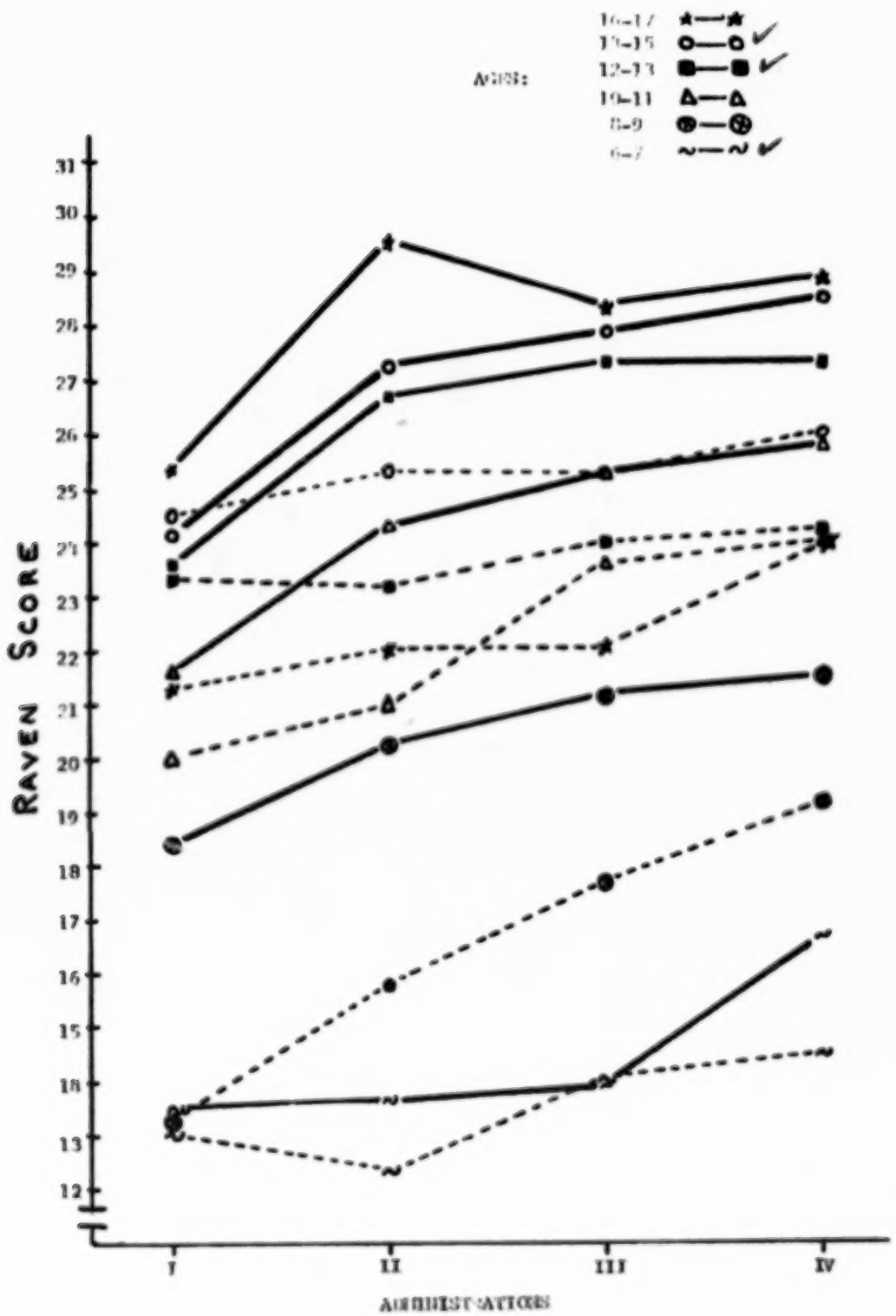
	C	NC	
6-7	5-10	5-3	+7
8-9	6-10	6-1	+9
10-11	7-11	7-10	+1
12-13	8-10	8-2	+8
14-15	9-10	10-8	-10
16-19	11-2	10-8	+4
Mean	8-5	8-1	4 months diff.

Mean GAINS for Coached (solid line) and Noncoached (broken line) Groups as a Function of MENTAL AGE (MA), for D_1 only.

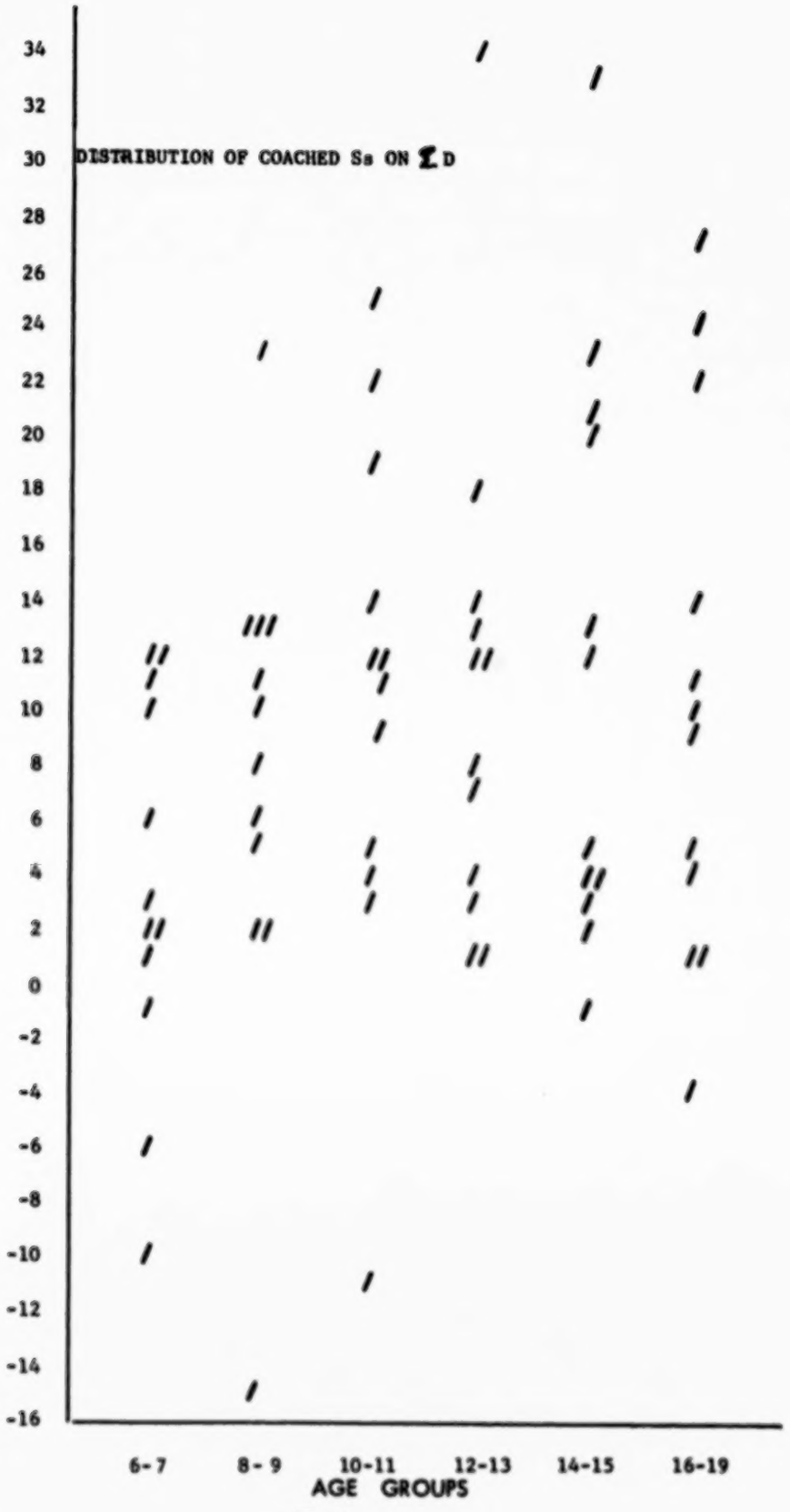


Appendix E

Mean RA/EI Scores for Coached (Solid Line) and Uncoached (Broken Line) Groups over Four Administrations.



Appendix F



F-1

Appendix G

Raven Guided Interview

Code_____
Child_____ School_____ Teacher_____
Date_____

I'd like you to tell me about _____. Whatever you say will be held in confidence, and neither you nor the child will be identified in future, so please be as complete and frank as you can.

Please give me an observation, a vignette, which typifies this child in your mind.

What are his typical traits? Annoying traits--Pleasing traits?

What about him worries you most?

What is his main school trouble?

What is his main trouble with you? How does he get along with you?

What discipline do you use with him?

What seems to work?

What do his parents use?

What are his working habits?

Does he ask for help?

How does he respond to help offered?

What has been said to him about his failures?

How does he react?

How aware is he of his problems?

What does the child think of himself, do you think?

What is his usual mood?

How does he get along with other kids?

Does he have any friends?

What kinds does he seek out?

What do the other kids think of him?

What does he do during free time? e.g.,activity versus passivity.

What does he do on the playground?

Do you know anything about his home situation?

Do you know anything about his sibs?

Parents' education?

Parents' job?

What is parental handling of current school problems?

Any medical history known to you?

Toilet problems?

Sex problems?

Does he have any nervous habits?

What are his strong points, his biggest assets?

What is he competent in?

What does he take joy in?

What are your ideas about the causes of his problems?

Appendix H

Raven Behavior Checklist

Code_____
Child_____ School_____ Teacher_____
Date_____

Comparing this child to others of his age in your room, please mark "X" if item is fairly typical of this child, and "XX" if it is markedly true.

ACADEMIC WORK HABITS

_____ Requests help
_____ Accepts help when offered
_____ Refuses help
_____ Distractible
_____ Interested in progress
_____ Goal oriented in work
_____ Needs extrinsic motivation
_____ Needs support
_____ Accepts new material
_____ Poor attention span
_____ Can't accept frustration
_____ Can work alone
_____ Can find acceptable activities during free time
_____ Uses academic work as a bargaining device
_____ Is easily frustrated and stops work
_____ Periodic intensive interest in one subject at a time
_____ Sets up obstacles to own work
_____ Can show initiative in making own assignments
_____ Ability to do rote work
_____ Ability to comprehend
_____ Ability to reason
_____ Applies learning
_____ Makes transitions in routine unaided

INDIVIDUAL BEHAVIOR

_____ Nailbiting
_____ Speech defect
_____ Grimaces
_____ Mobility
_____ Noisy

_____ Aggressive
_____ Withdrawn
_____ Timid
_____ Demands attention

_____ Acceptable personal grooming
_____ Low energy Level

_____ Destructive
  _____ self
  _____ own property
  _____ others
  _____ others' property

_____ Distractible
_____ Fantasies
_____ Daydreams
_____ Fabricates stories
_____ Fearful of new situations
_____ Worries over failure
_____ Impulsive
_____ Awareness of routine
_____ Conforms to routine
_____ Makes individual transitions in routine unaided

SOCIAL BEHAVIOR

(1) Interaction with Peers

_____ Accepted
_____ Ignored
_____ Shunned
_____ Picked on

_____ Bullies
_____ Bluffs
_____ Steals
_____ Lies
_____ Cheats
_____ Shows off
_____ Quarrels
_____ Plays with younger children
_____ Teases
_____ Tattles
_____ Selfish
_____ Provocative

_____ Positive leader
_____ Negative leader
_____ Positive follower
_____ Negative follower

_____ Giggles
_____ Cries
_____ Language unacceptable
_____ Solitary and lonely
_____ Cooperative
_____ Participates in groups
_____ Accepts individual responsibility
_____ Accepts group responsibility
_____ Runs out of class
_____ Maneuvers adults
_____ Resents attention to others
_____ Temper tantrums

(2) Relationship with Teacher

_____ Positive relationship
_____ Fears Teacher
_____ Distrusts Teacher

_____ Seeks out Teacher
_____ Dependent on Teacher
_____ Challenges Teacher
_____ Resists Teacher physically

Additional Comments: (if any)

Appendix I

Rating Scale for Historical Data

PHYSICAL INFLUENCES

0 - Physical history and motor performance well within normal range.
1 - Sensory problems, mild incoordination, mild speech defect, T & A.
2 - Considerable incoordination, "perceptual-motor dysfunction".
3 - Gross incoordination, major physical problems, such as series of operations, active rheumatic fever, major head trauma.

HOME: DEVELOPMENTAL-EMOTIONAL INFLUENCES

0 - Good home, or well within normal range.
1 - Mild neurotic interaction of mother/father with child, e.g., mother somewhat over-indulgent, father somewhat over-punitive; good one parent home.
2 - Considerable grossly neurotic interaction; continual strife in home; broken home.
3. - Gross neglect, deprivation (psychic or physical), psychotic parent; "hot" broken marriage, the "problem family" welfare case.

HOME: CULTURAL LEVEL AND INFLUENCES

0 - Benign representative of middle class values; HS+ education.
1 - "TV Home"; HS- or GS education; or MC home with crass values, e.g., exaggerated money or status interests.
2 - "Slow Learner" parent; non-verbal but otherwise relatively benign 'back country' home.
3 - Pernicious 'back country' home.

Rating method: Each subject rated on all three areas by clinical impression of interview and file material, as well as clinical impression of child. + and ++ ratings were assigned when the overall impression was intermediate between above levels.

Appendix J

Gainers vs. Losers on Σ H Score

A = Gainer-Loser
B = Chronological Age
C = M.A.

a = 2 (fixed)
b = 6 (fixed)
c = 4 (fixed)

Source	SS	df	MS	F	F crit p < .05	F crit p < .01	Conclusion
A	697.69	1	677.69	4.36	(1,30) 4.17	7.77	p < .05
B	2,646.19	5	529.24	3.31	(5,30) 2.53	3.70	p < .05
AB	1,018.18	5	203.64	1.27	2.53	3.70	NS
C	546.23	3	182.08	1.14	(3,30) 2.92	4.51	NS
AC	1,555.72	3	518.57	3.24	2.92	4.51	p < .05
BC	2,647.89	15	176.52	1.23	(15,15) 2.48		NS
ABC	2,150.91	15	143.39				
	11,268.85	47					

$$\text{Error (pooled)} = \frac{2{,}647.89 + 2{,}150.91}{15 + 15} = \frac{4{,}798.80}{30} = 159.96 \quad df = 36$$

Appendix K

Capsule Backgrounds of Extreme Gainers and Losers.

Extreme Gainers

#38, Male Infantile, very passive, pesty last child of older mother. Relatively good home. Has temper tantrums, teases, is a provocateur. Good in academics.

#29, Male Very much the individualist, ingenious, creative. Balky, stubborn. Rather neglected in a poor home situation. Mother, probably retarded herself, has now gone to work. Last year very close to father, now less so.

#56, Fem. Very slow, though eager to learn, works hard. Good family. Mother retarded but concerned, helpful. May be brain injured. Somewhat withdrawn, worries about failure.

#55, Male Calm, well liked, competent. Must be from good home. Has low energy level, no memory for facts.

#26, Male Though academically most capable in class, must have public approval. Many anal-sadistic traits. Mother abandoned; he now lives with father, sister, step-mother and new baby. He is blamed for much marital discord.

#68, Fem. A good girl. Parents want to give her social experience. Trustworthy, a hard worker, but can't read.

#23, Male A sorely deprived, neglected child. Has non-verbal skills, toughness despite continual trauma. Had anemia.

#53, Male Small, dull boy from hill family with many sibs. A pesky trickster. Distractible, impulsive, picks on and picked on. On fringe of delinquent group.

#66, Male From a good middle class home. A worker, looks for his own job. Has driver's license, trusted. Sensitive re his retardation, but not a worrier.

#36, Male — From good home. Had early deafness and other sensory problems. Immature, speech impediment. So odd looking he needs cosmetic operation. Understands 11 year old material, but reads at Grade 1 level.

#71, Male — Non-reader, but a deep thinker with excellent vocabulary. Lives with mother (separated) and grandmother, who disagree 3+. Confused when pushed. Has mechanical skills, repairs radios.

#58, Fem. — Wise, a thinker. Reads. Good worker with terrific drive, stubborn. From happy but messy home.

#46, Male — Stolid, naive, a loner. Timid, dependent, fearful, unambitious. Parents do not answer teacher's notes.

Extreme Losers

#3, Fem. — Very anxious, deprived, feisty girl from chaotic though intact home. Was a soiler. 8 sibs, 5 in a bed, but color TV, 2 cars and no milk money.

#57, Fem. — Pretty, dull, hysterically denying girl from broken home. Mother masochistic, passive; father philanders, beats her and near-delinquent sister. Lives now with one relative, now another, reads 4+, no comprehension.

#61, Male — Clean boy, relatively well adjusted, works hard. Has pretty good opinion of self, but lonely, distractible. Needs operation for undescended testicle which he can't afford.

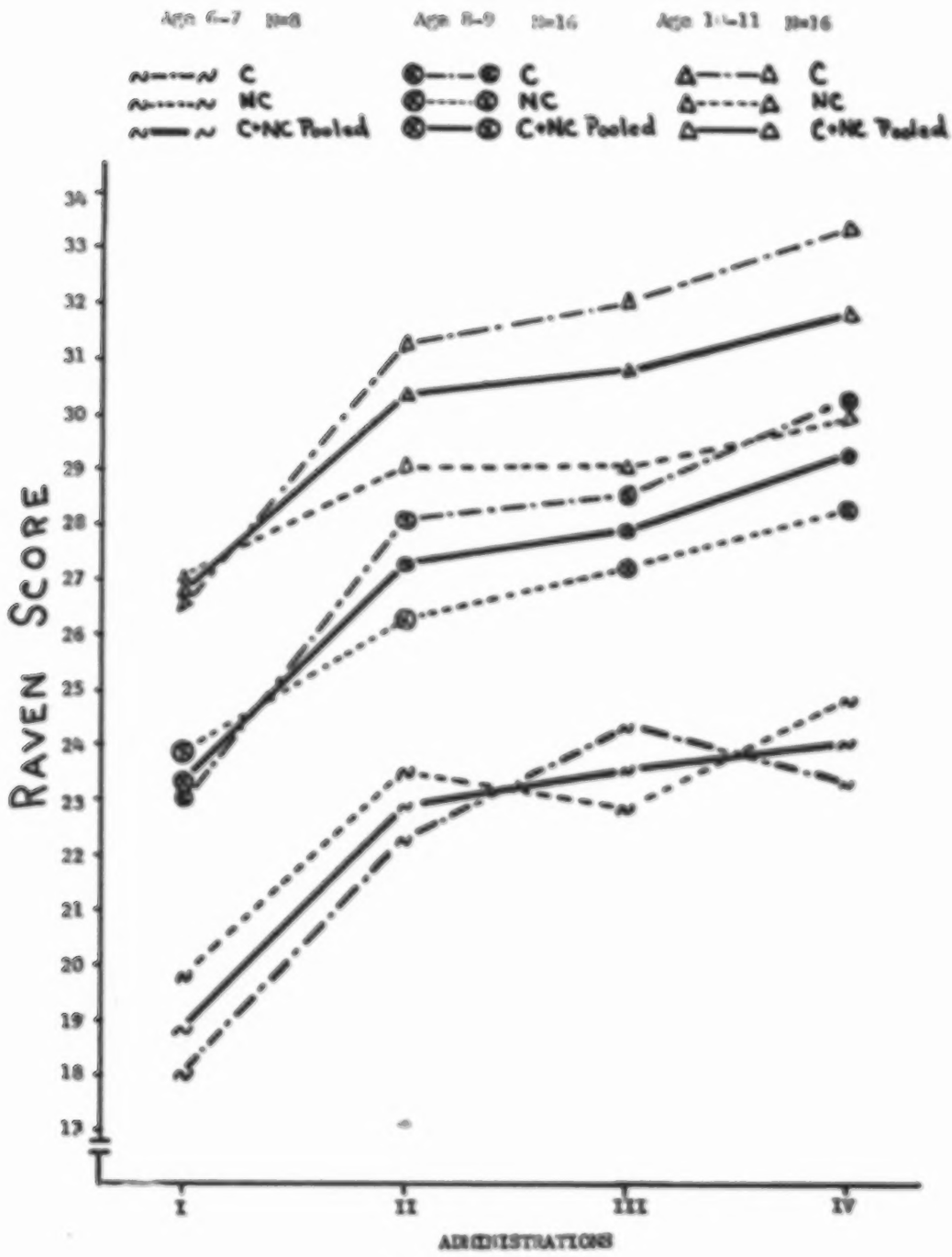
#6, Fem. — Very withdrawn, insecure. So afraid of doing something wrong she won't try. Father 3 times in mental hospital; mother beer drinker, vague, helpless. May have been premature. Was soiler, had strange mannerisms. Teacher says "not a slow learner."

#4, Fem. — A neurotic already, a complaining martyr. Driven to point of great anxiety by unfeeling, punitive, compulsive parents.

#27, Male	Reads at 7th grade level, but no social skills. Same home as #6, where he has to care for and teach other sibs, including 2 retardates. Used to vomit for fear of not performing right.
#18, Fem.	Only Negro of 620 children in building. Reads well 4th grade level. Sweet, well trained and cared for. Suffers also from earlier Mississippi education and fatherless home.

Appendix L.

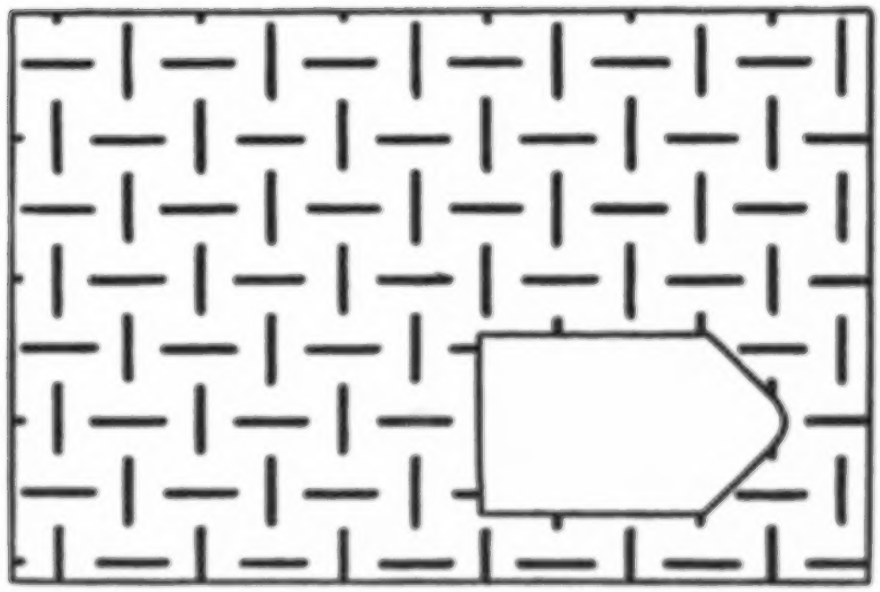
Mean RAVEN Scores for BOYS: Conchet (C) and Nonconchet (NC) Groups.

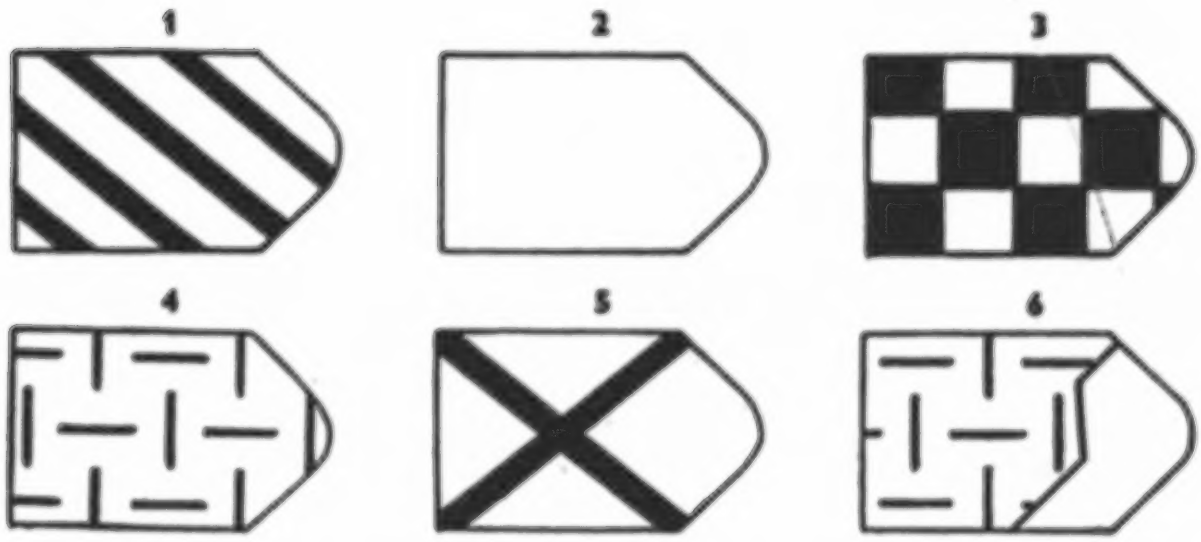


Appendix M

The Raven Matrices

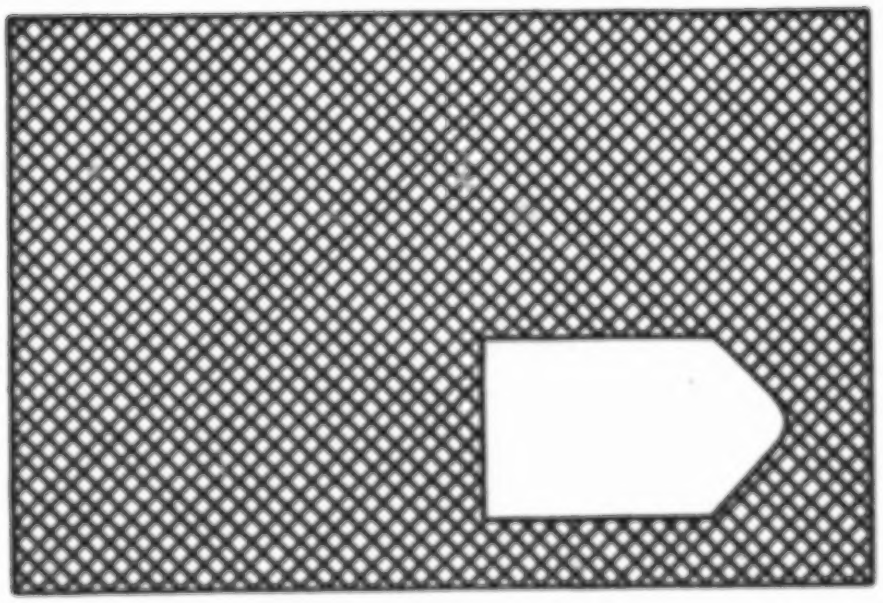
A 1

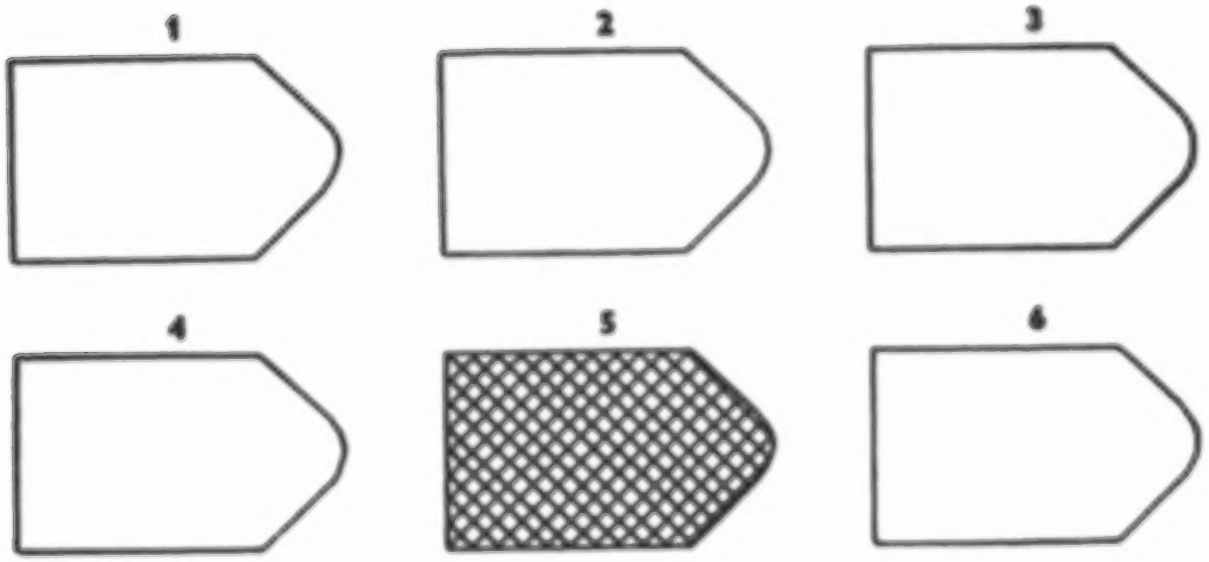




I

A 2

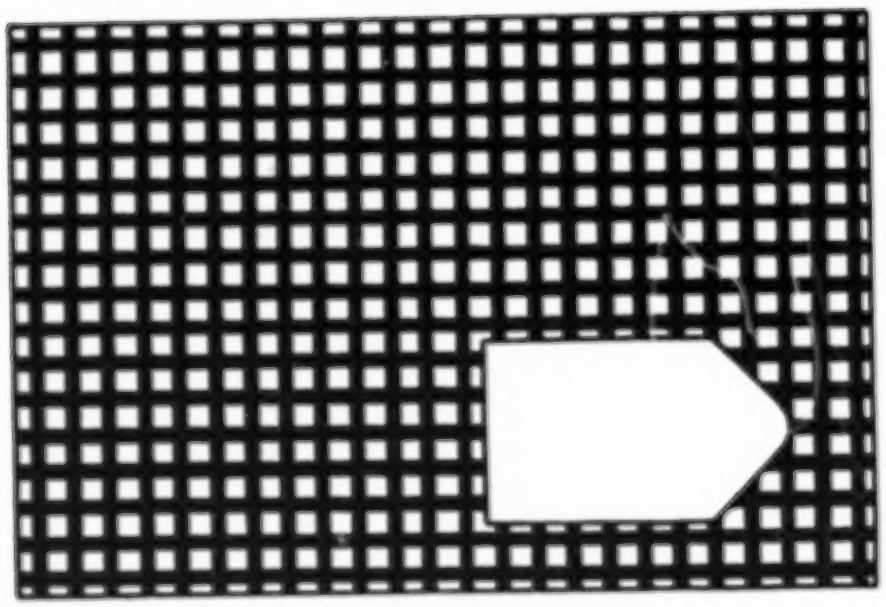


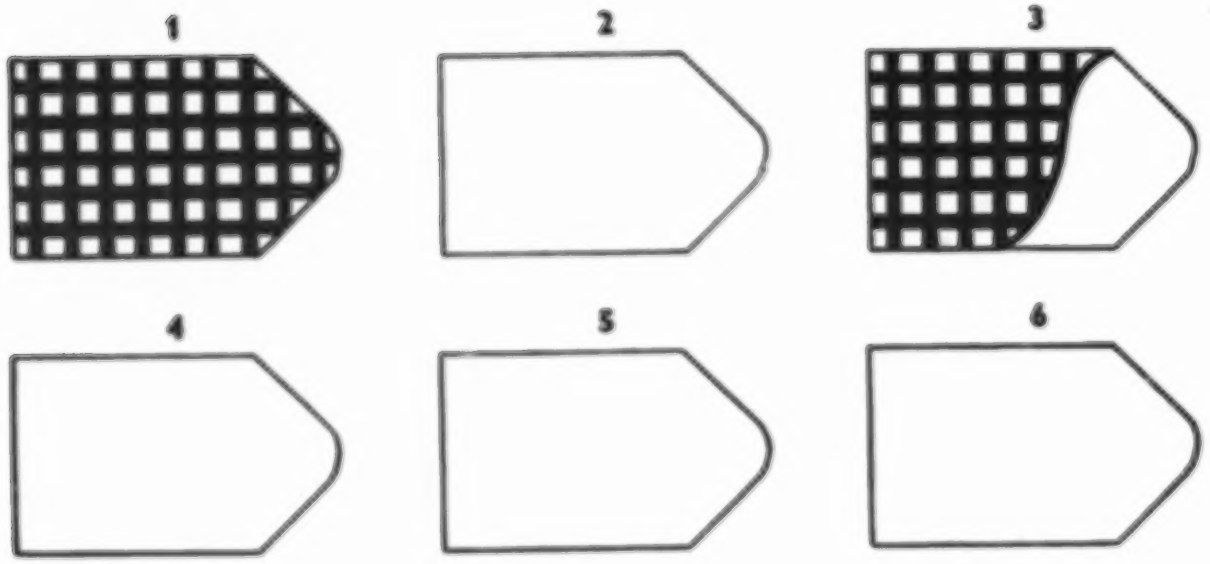


M-2

I

A 3

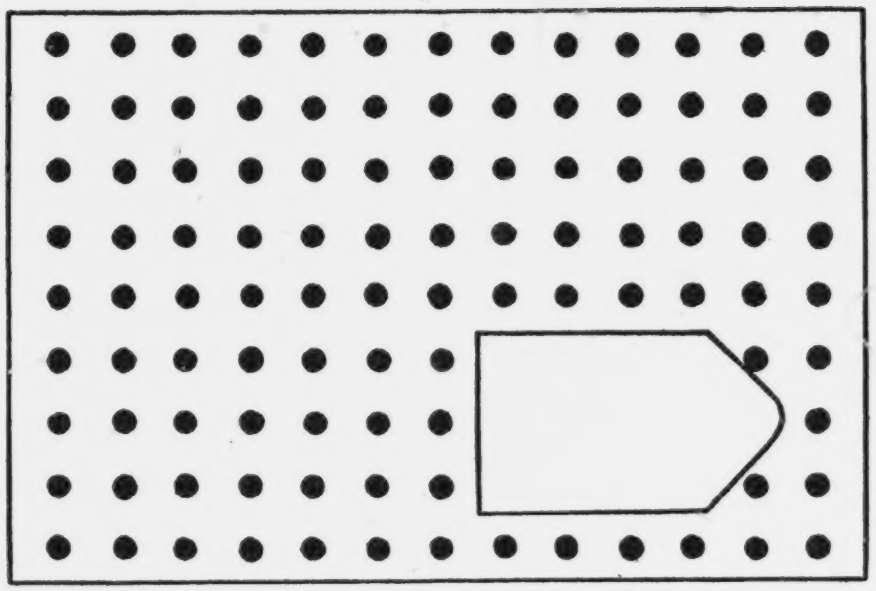


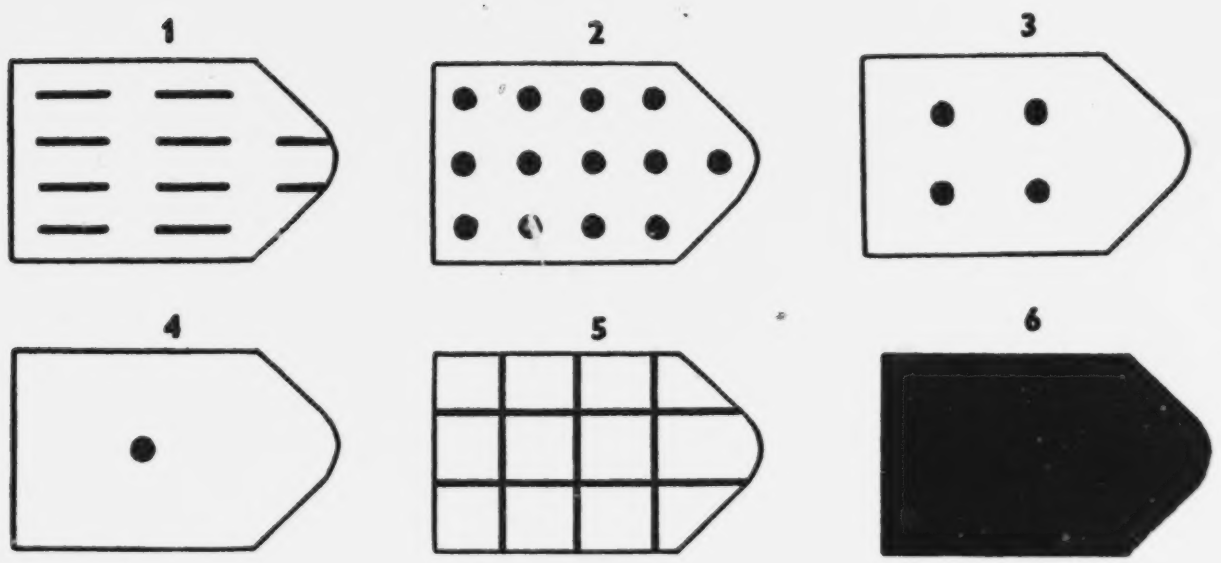


M-3

I

A 4

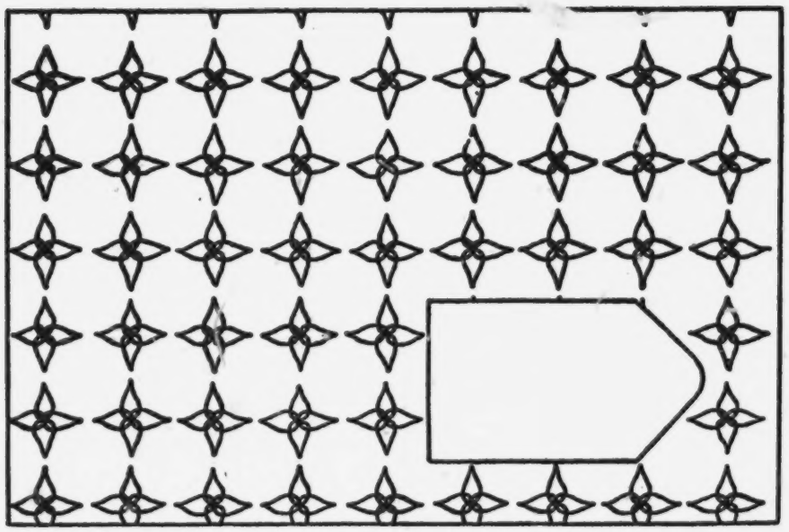


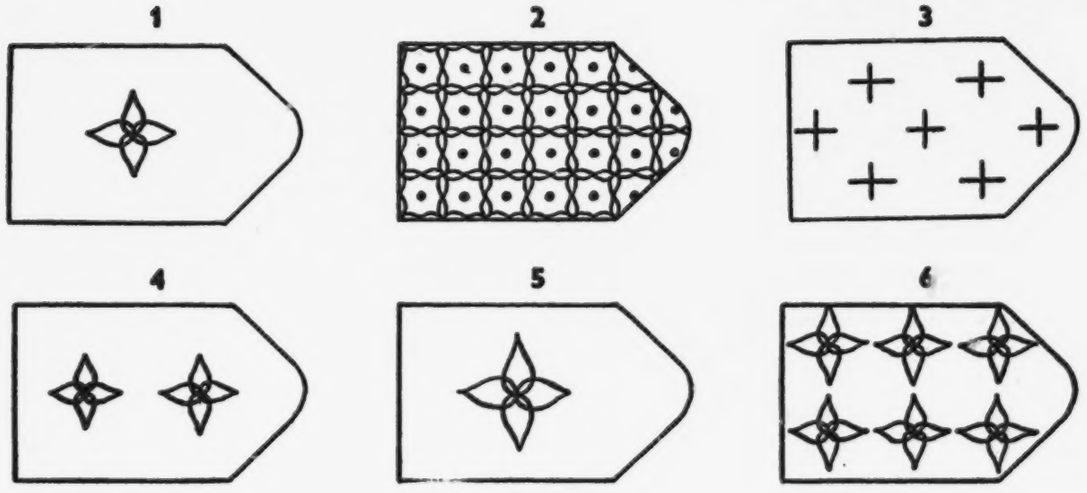


M-4

I

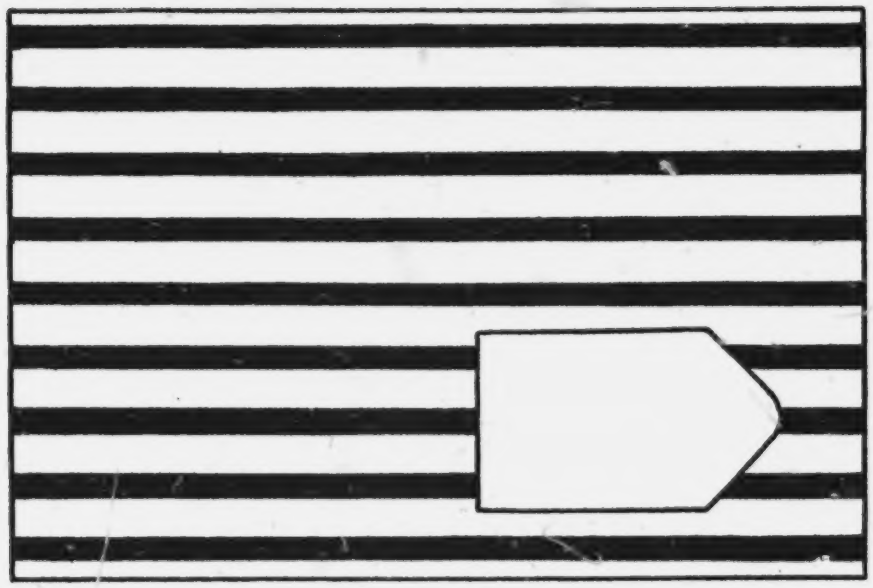
A 5

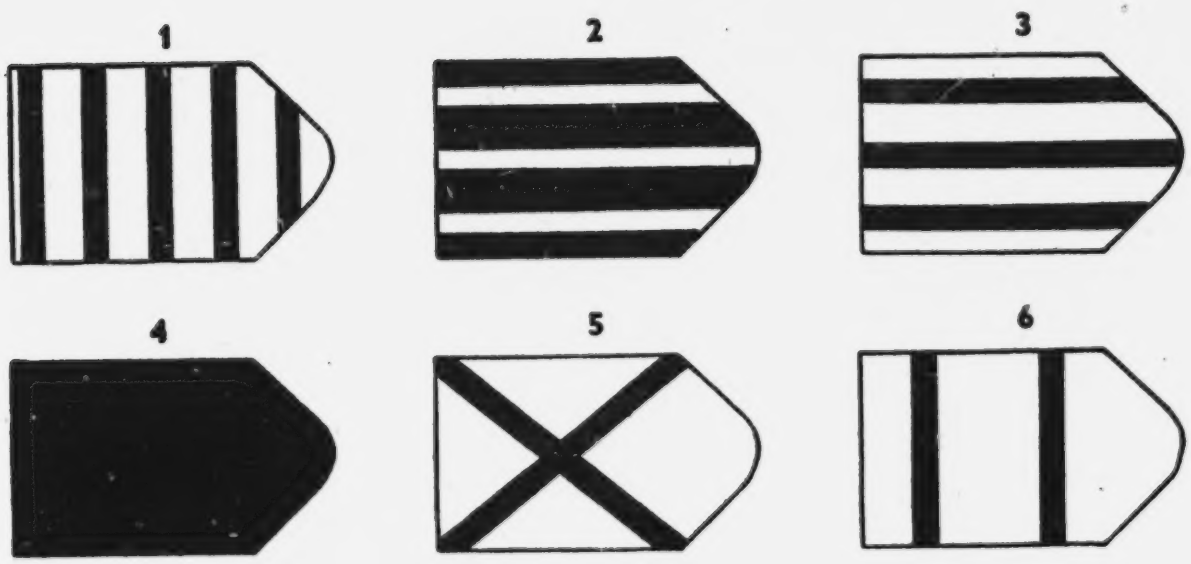




I

A6

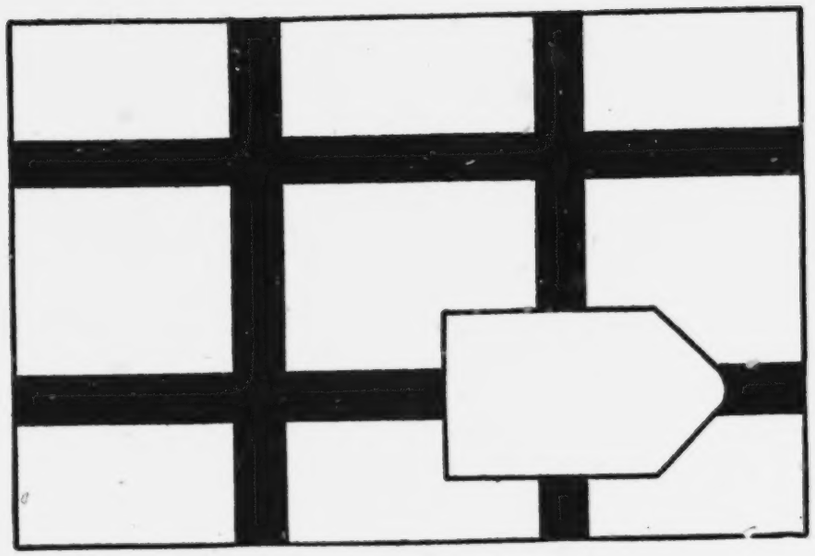


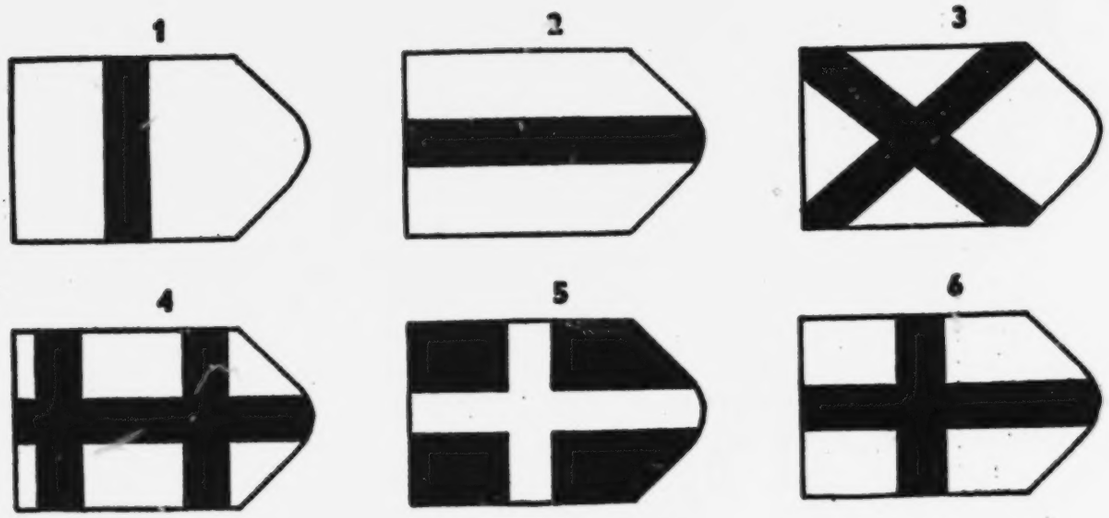


M-6

I

A7

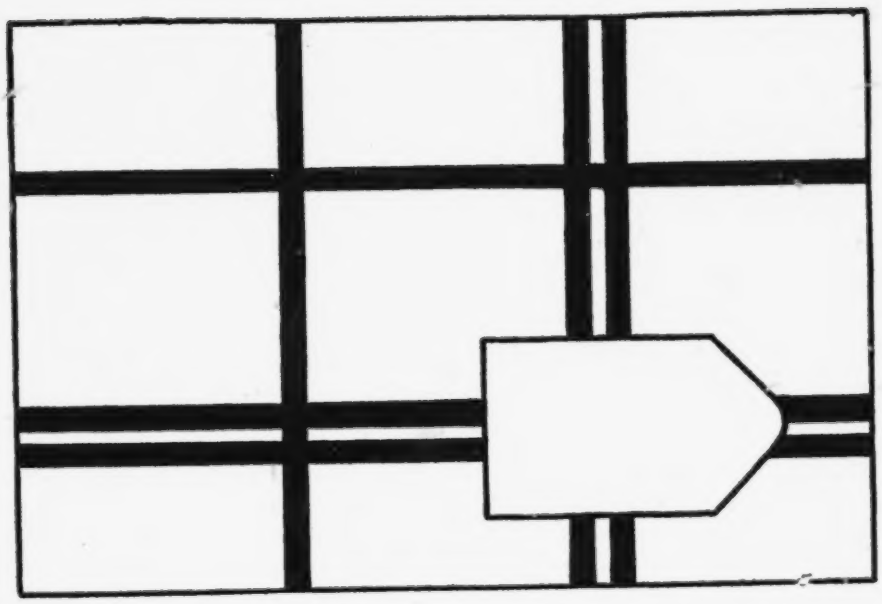


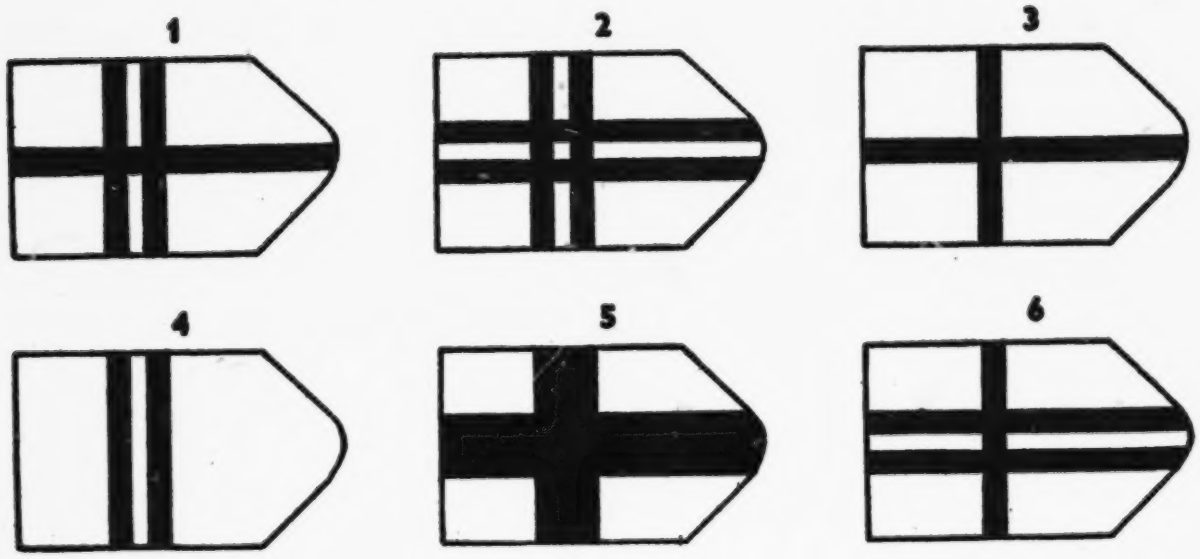


M-7

6

A 8

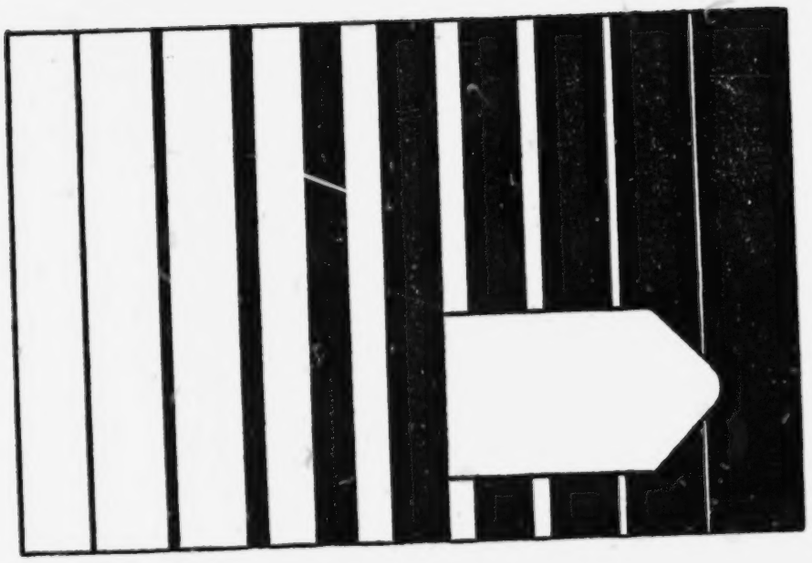


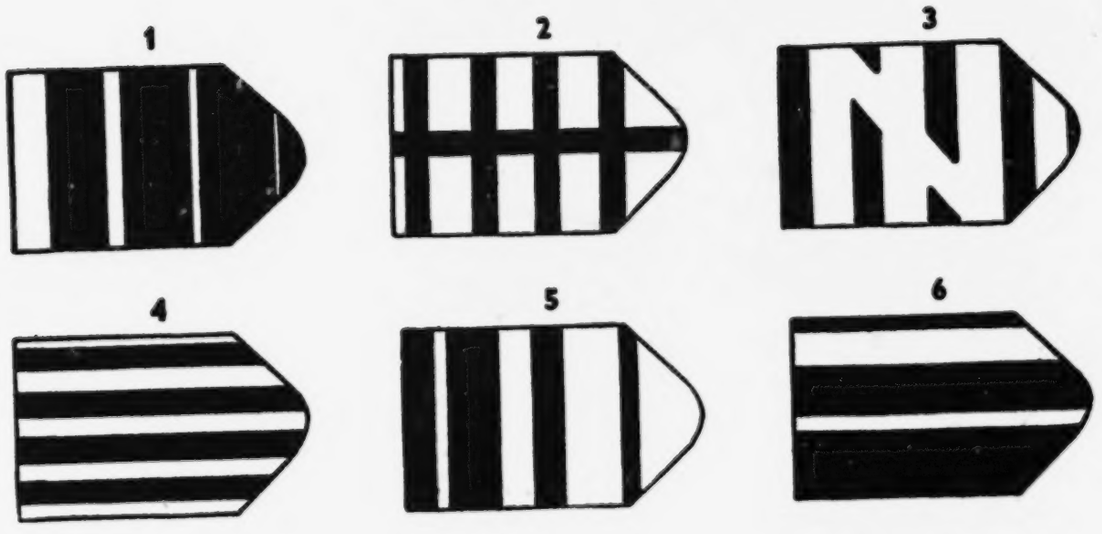


M-8

G

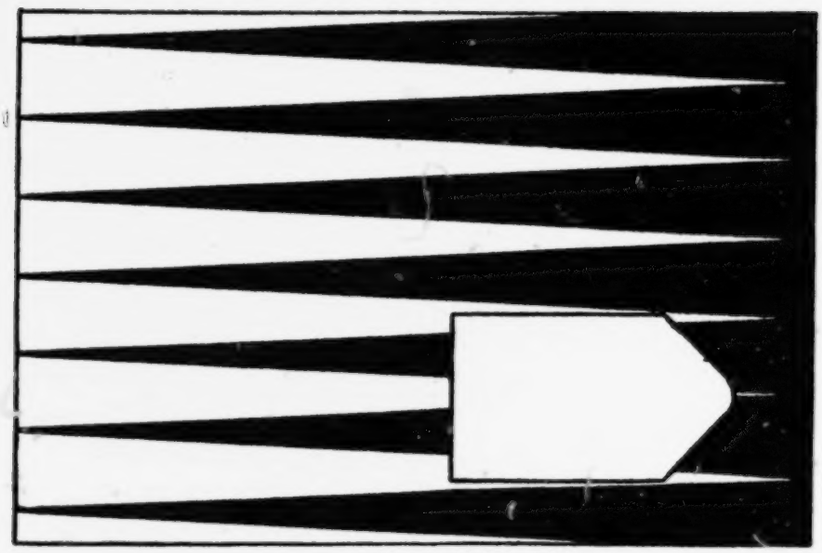
A9

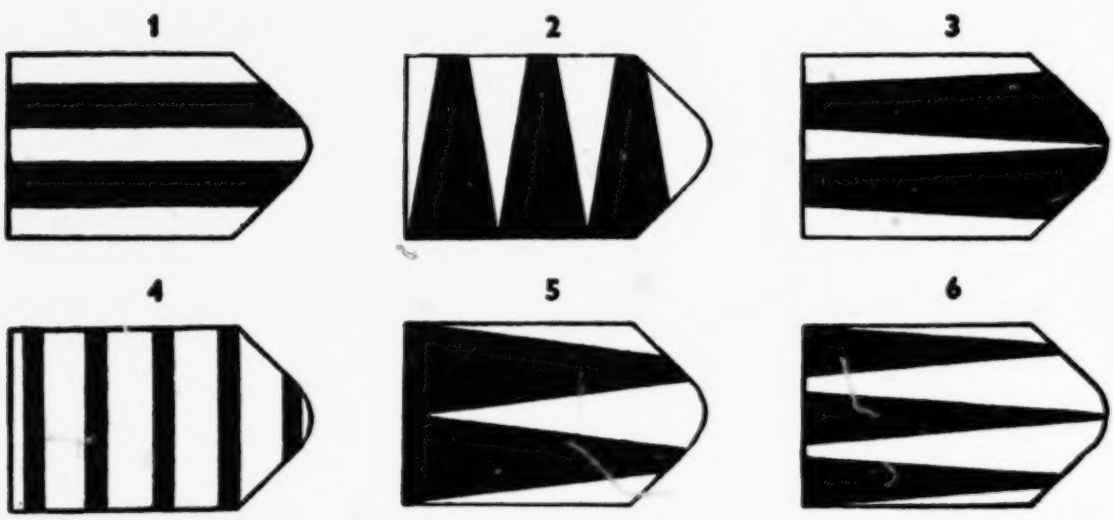




M-9

A 10

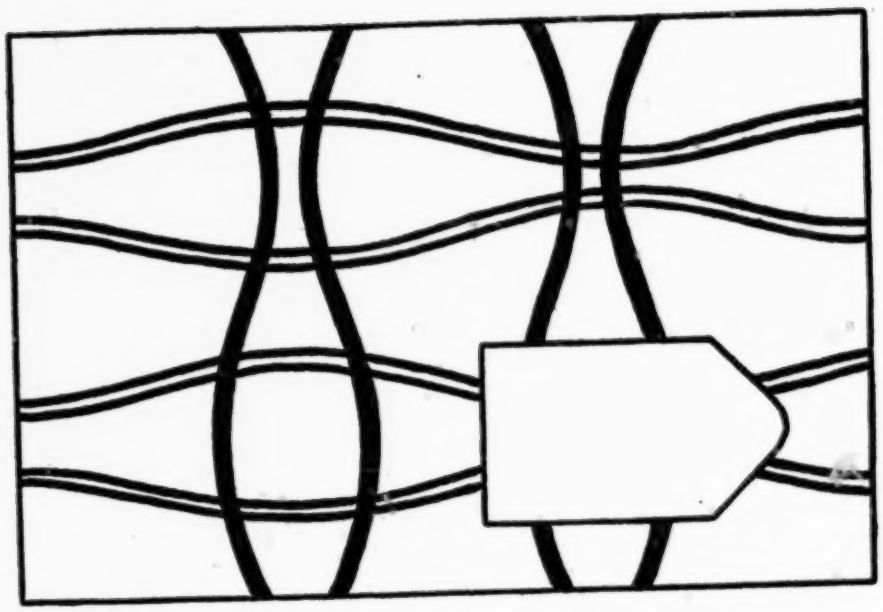


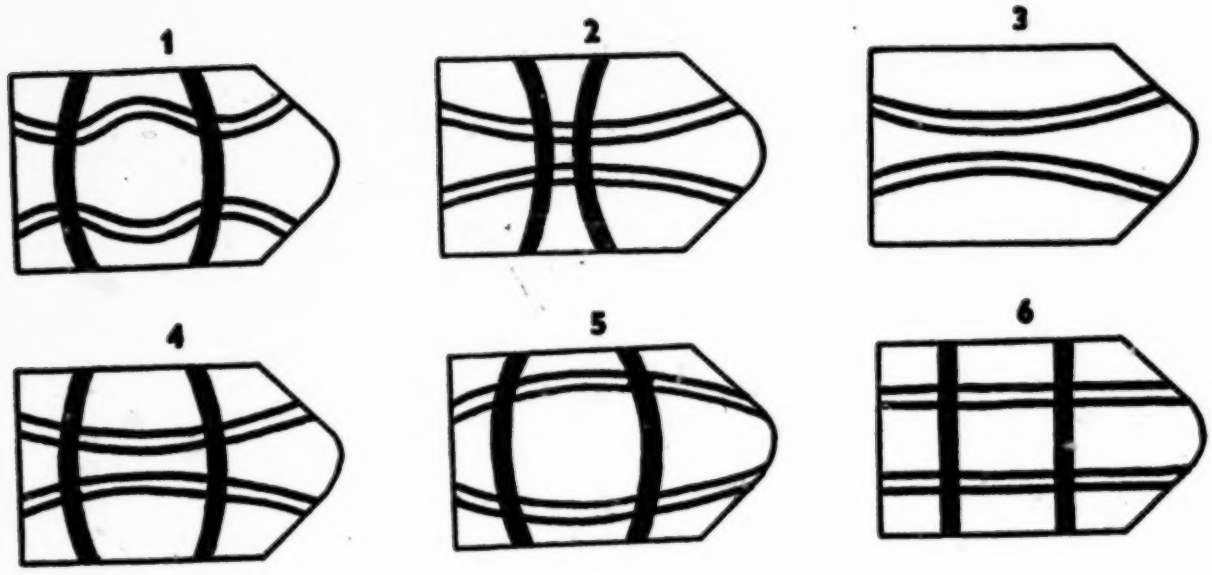


M-10

G

A 11

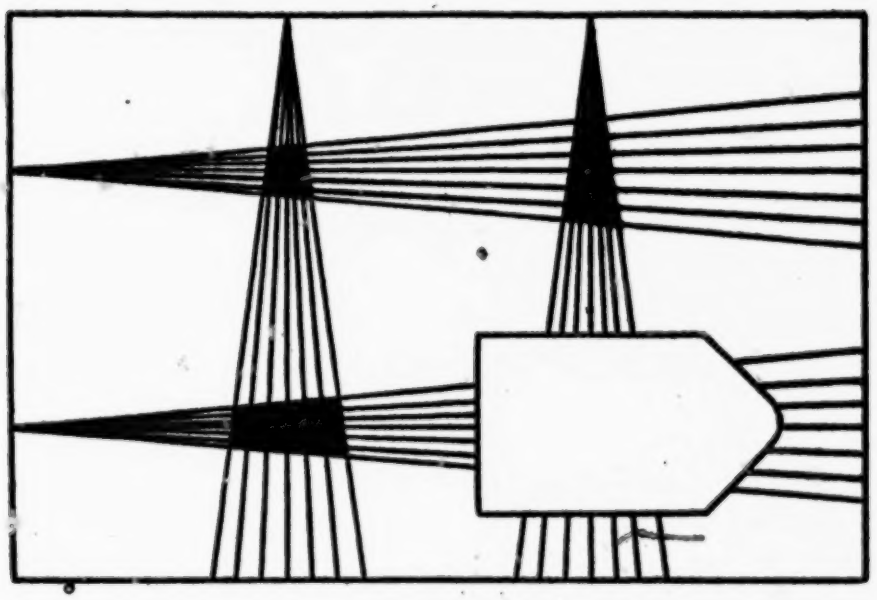


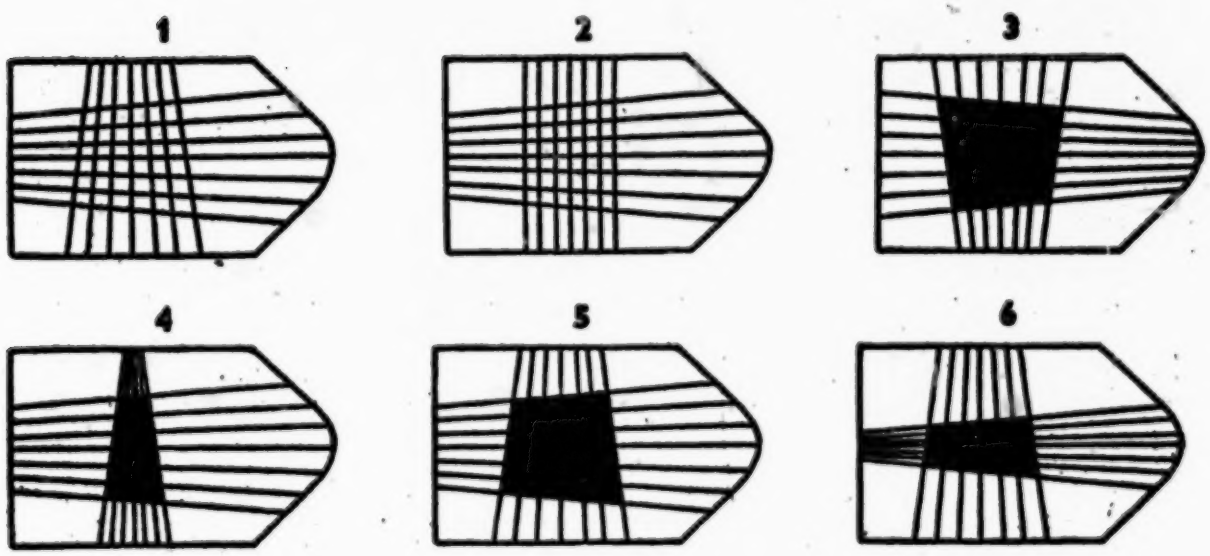


M-11

G

A 12



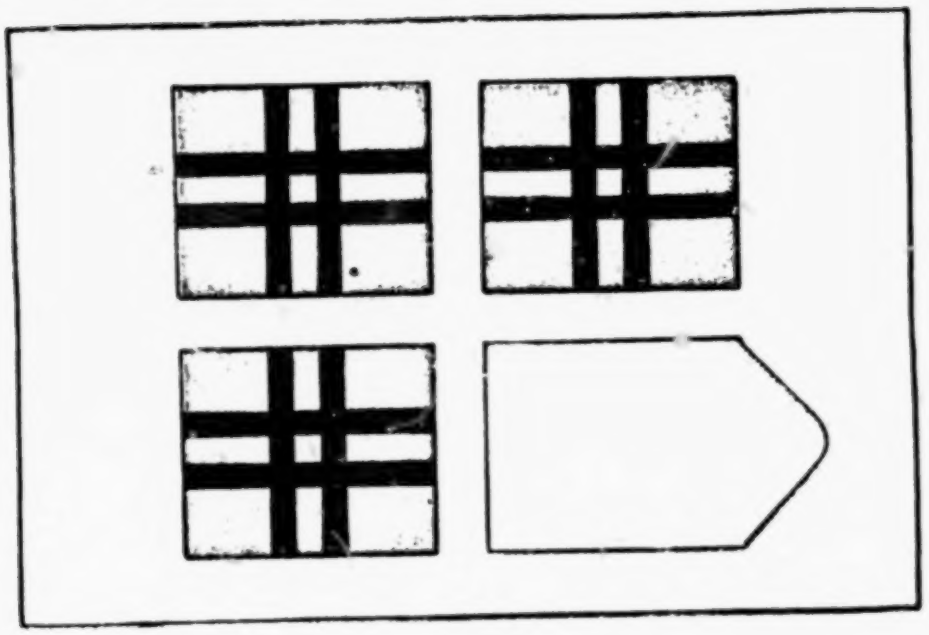


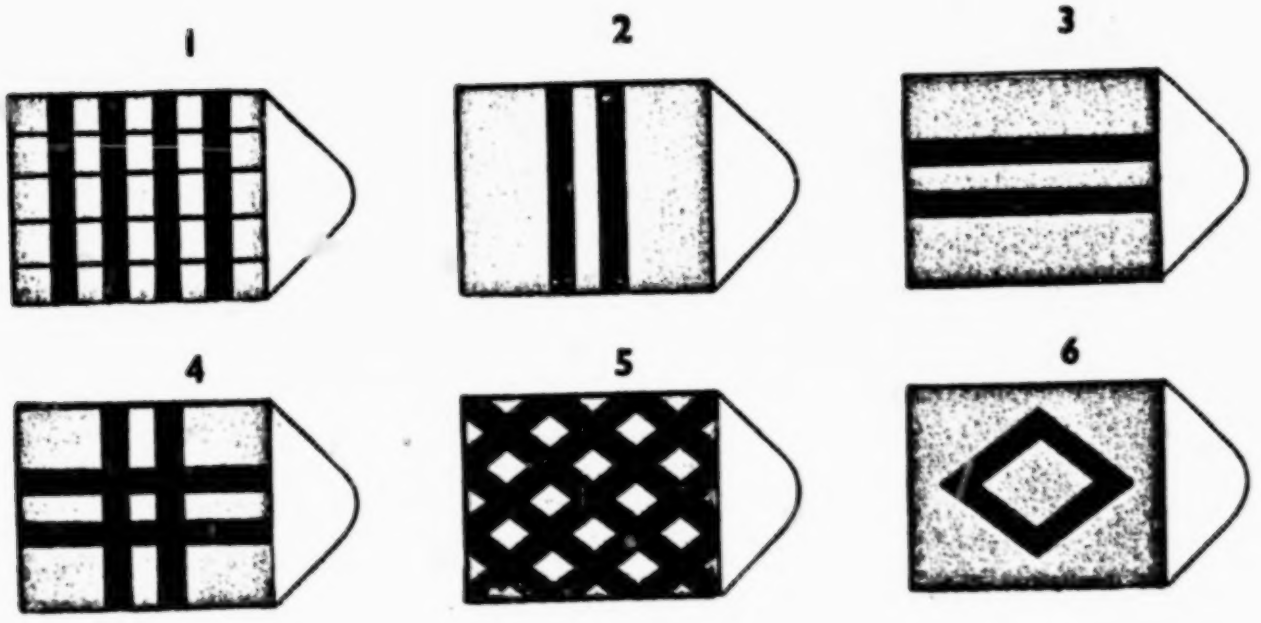
M-12

G

— A_B —

A_B I

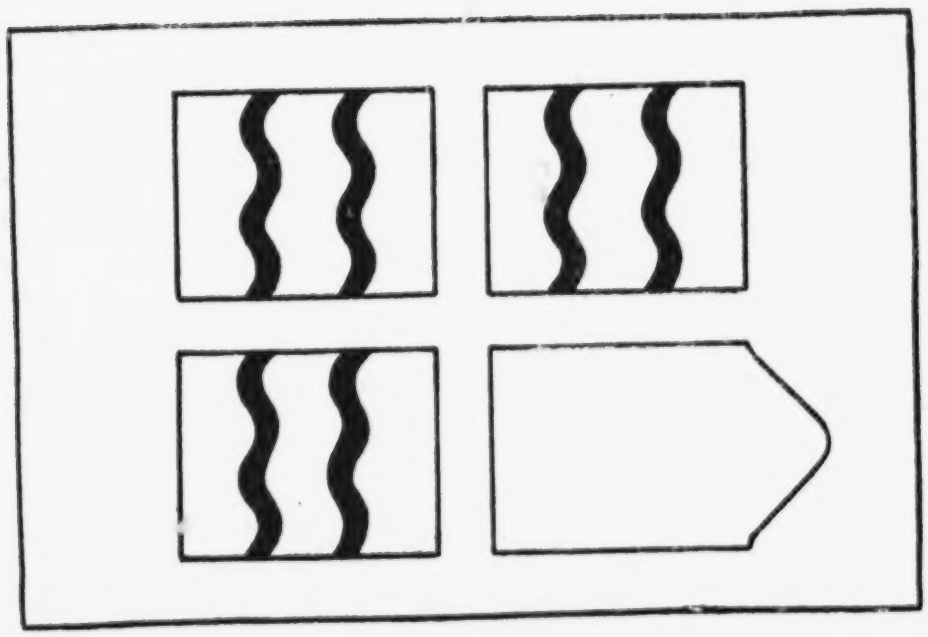


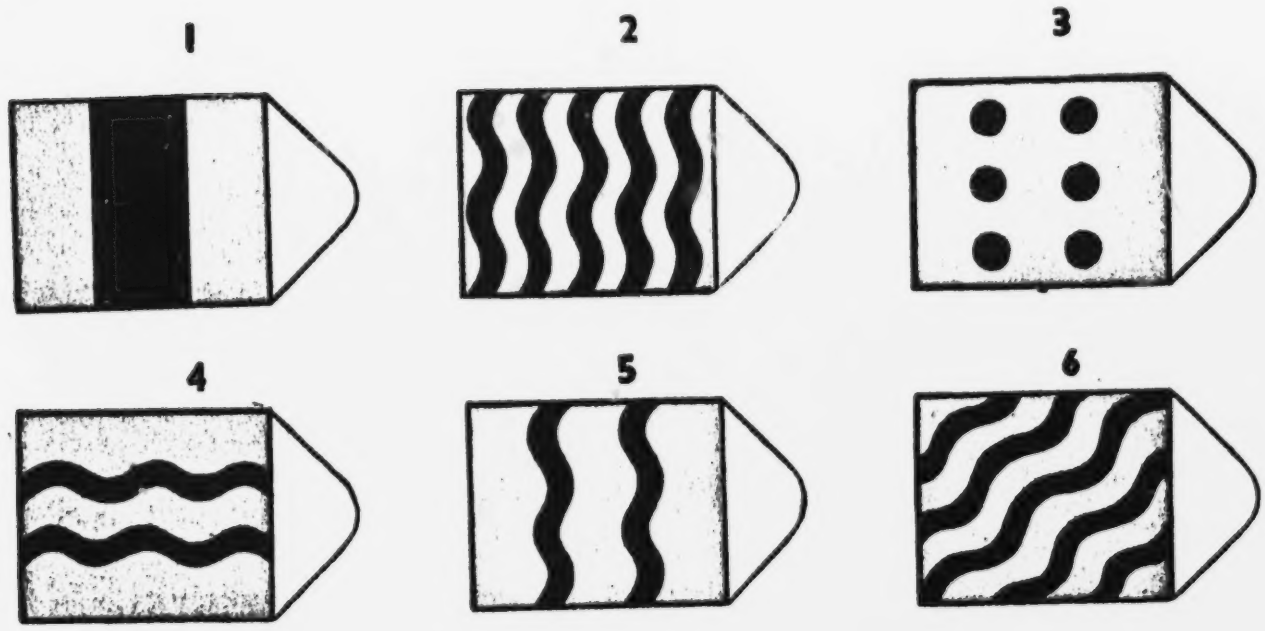


M-13

I

A_B 2

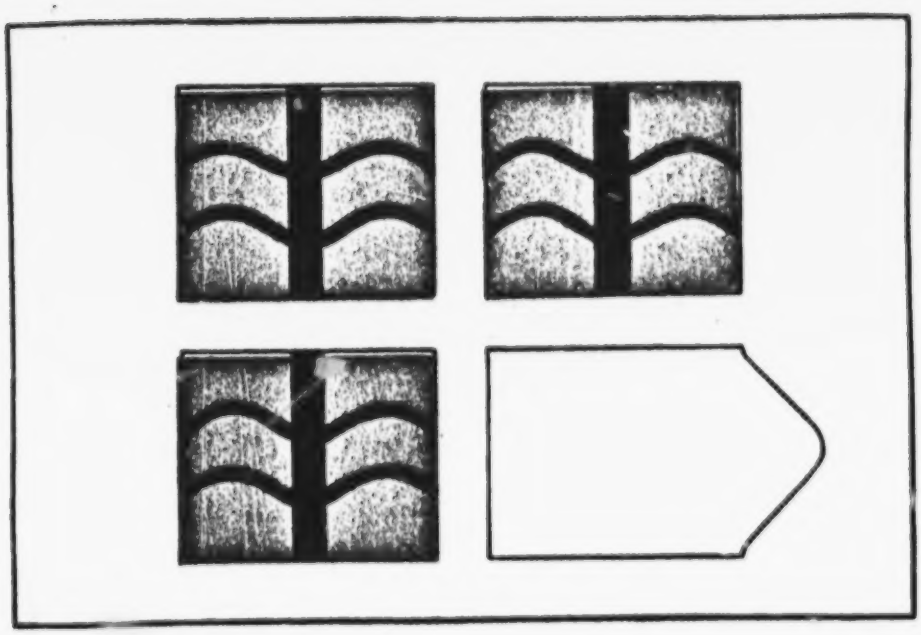


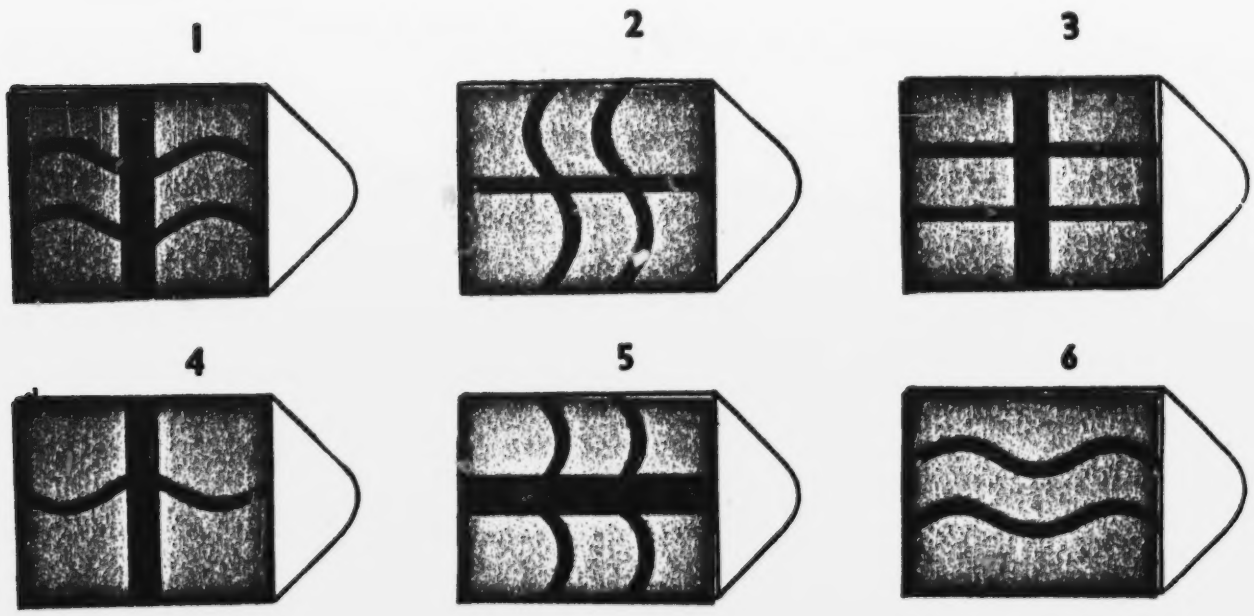


M-14

1

A_B 3

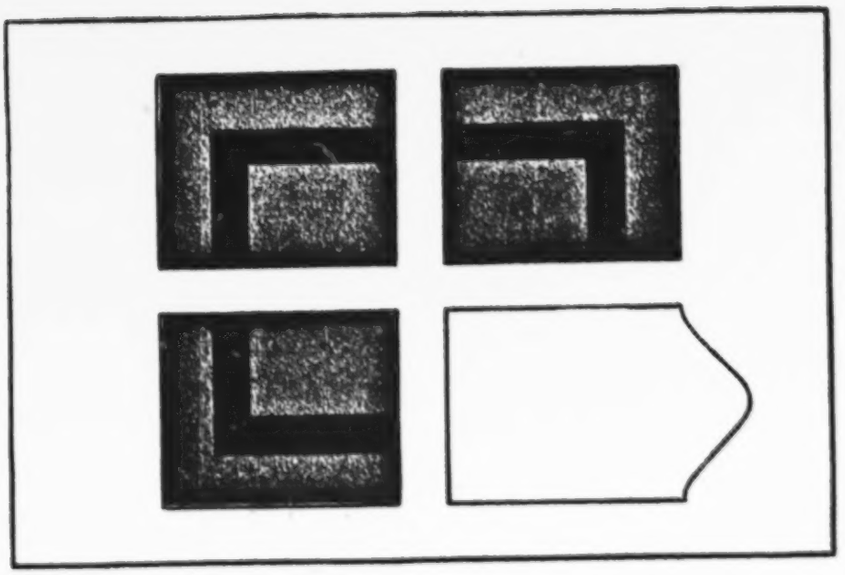


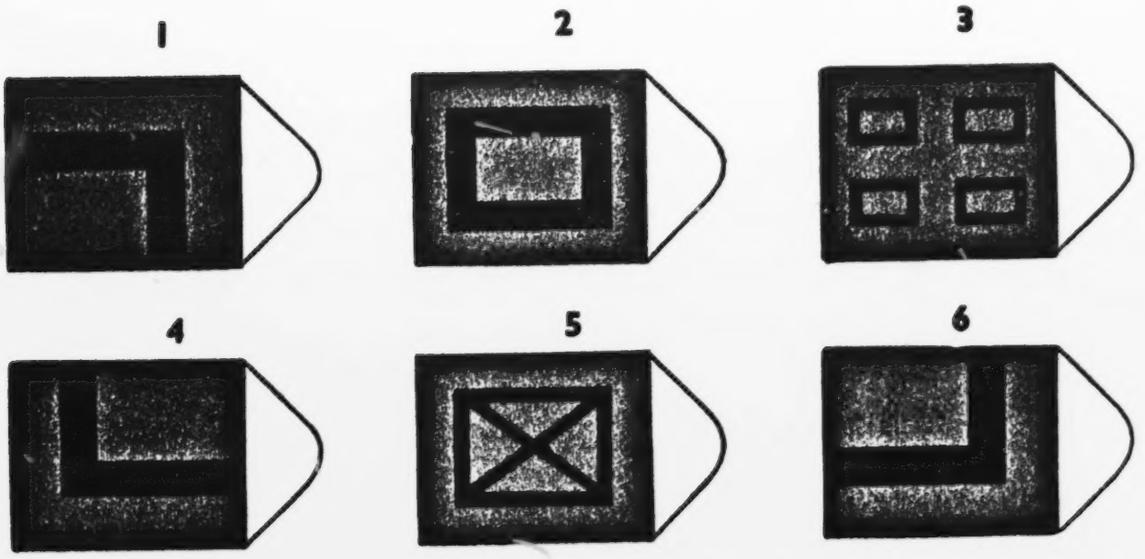


M-15

I

A_B 4

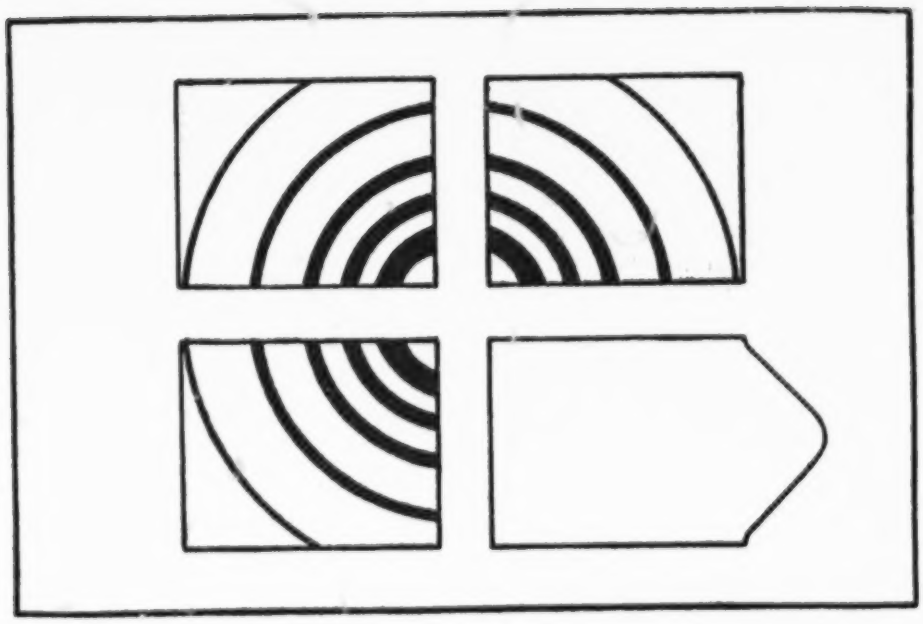


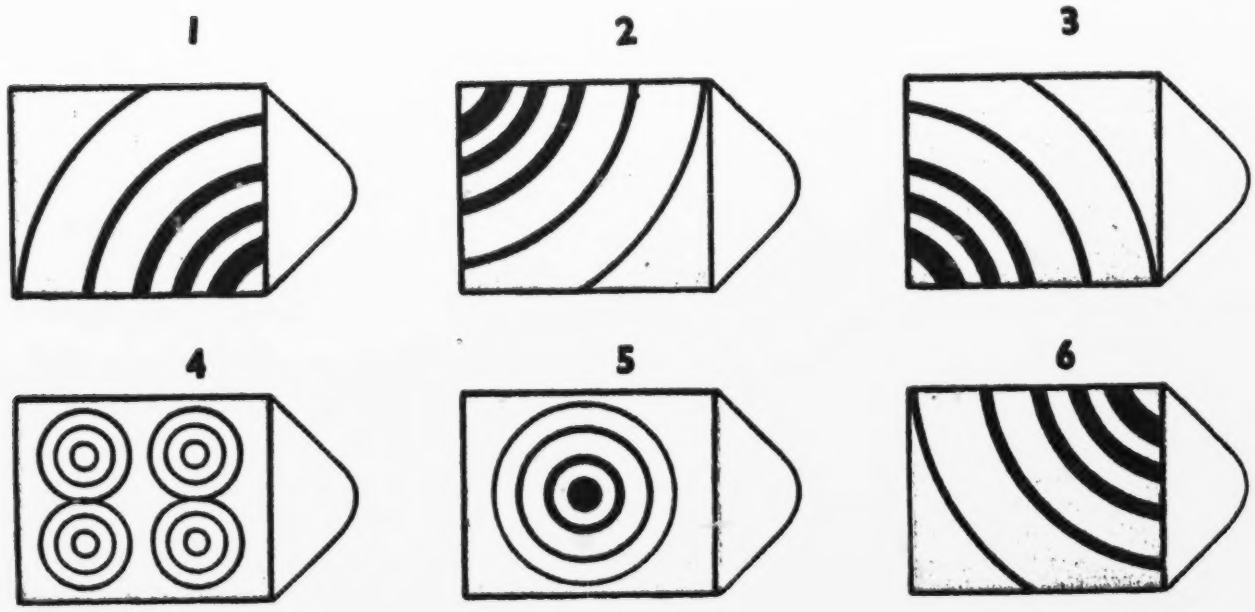


M-16

6

A_B 5

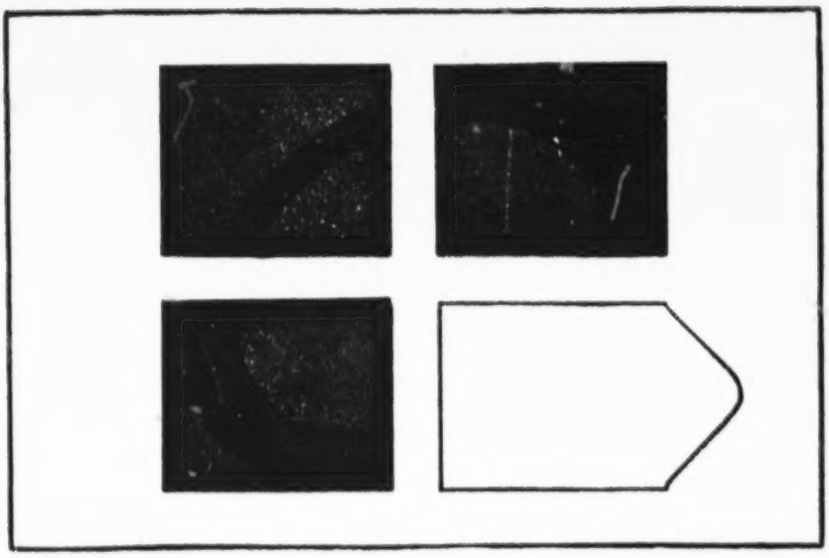


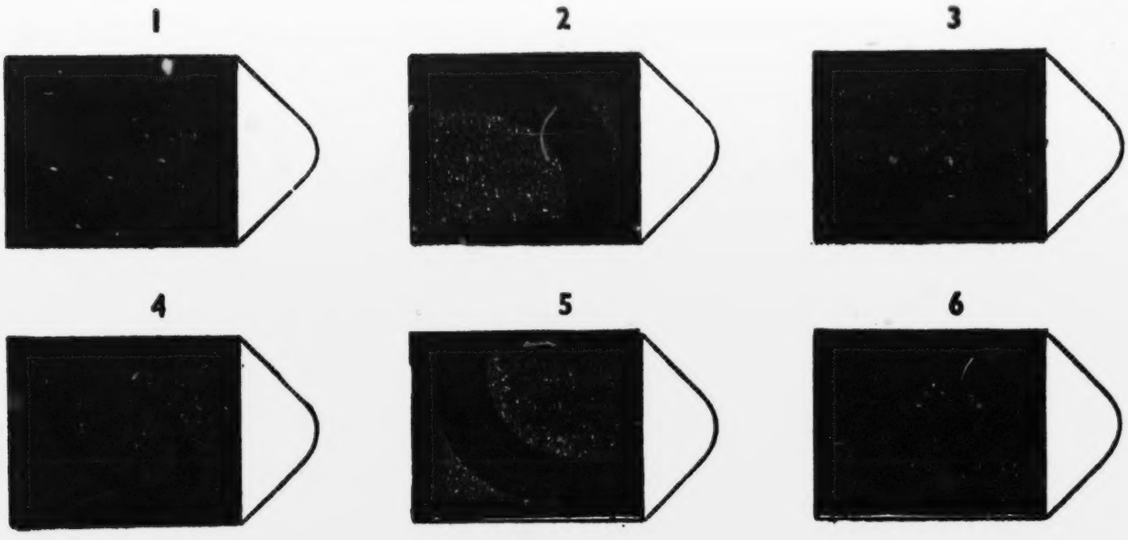


M-17

6

A_B 6

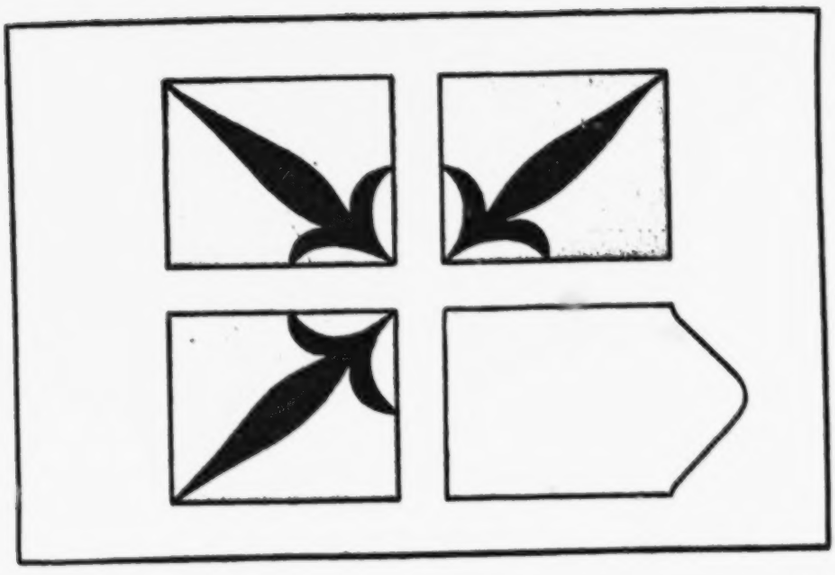


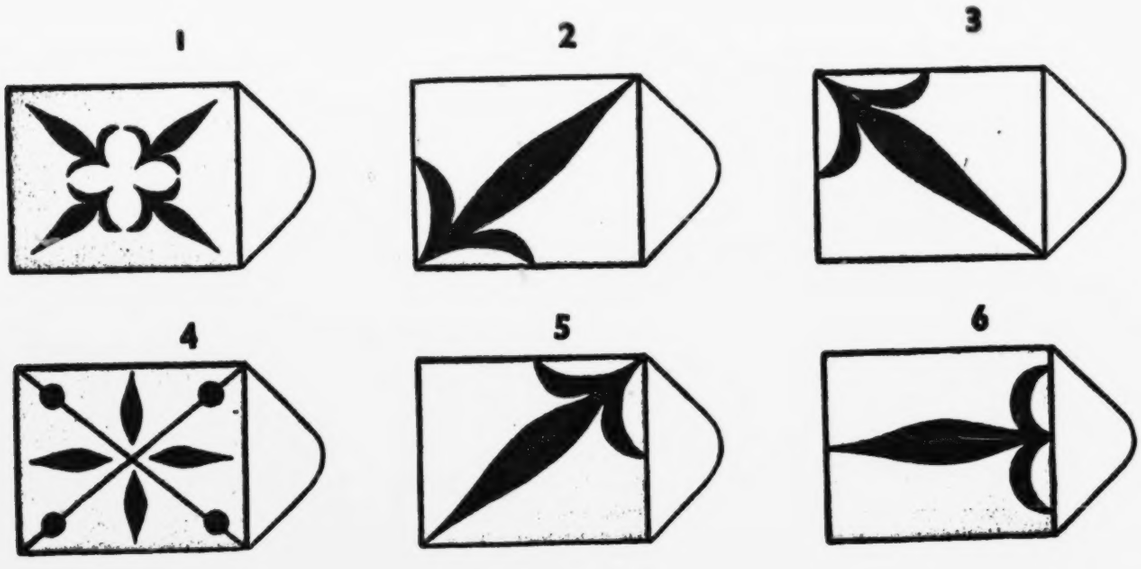


M-18

6

A_B 7

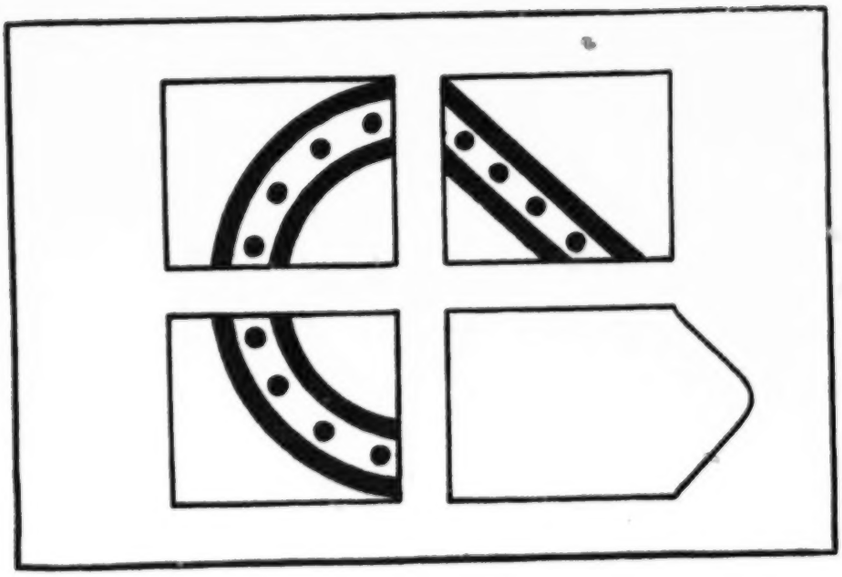


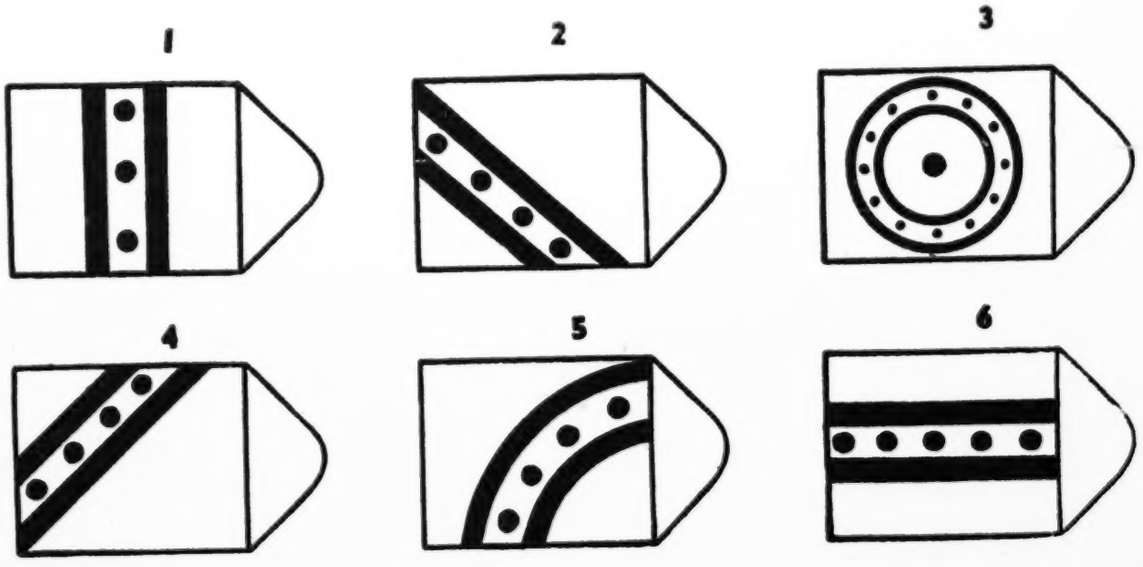


M-19

A

A_B 8

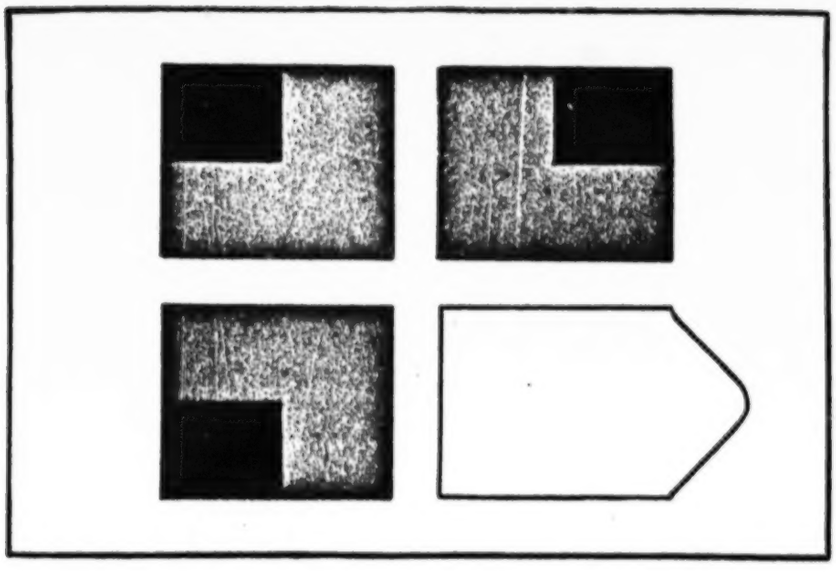


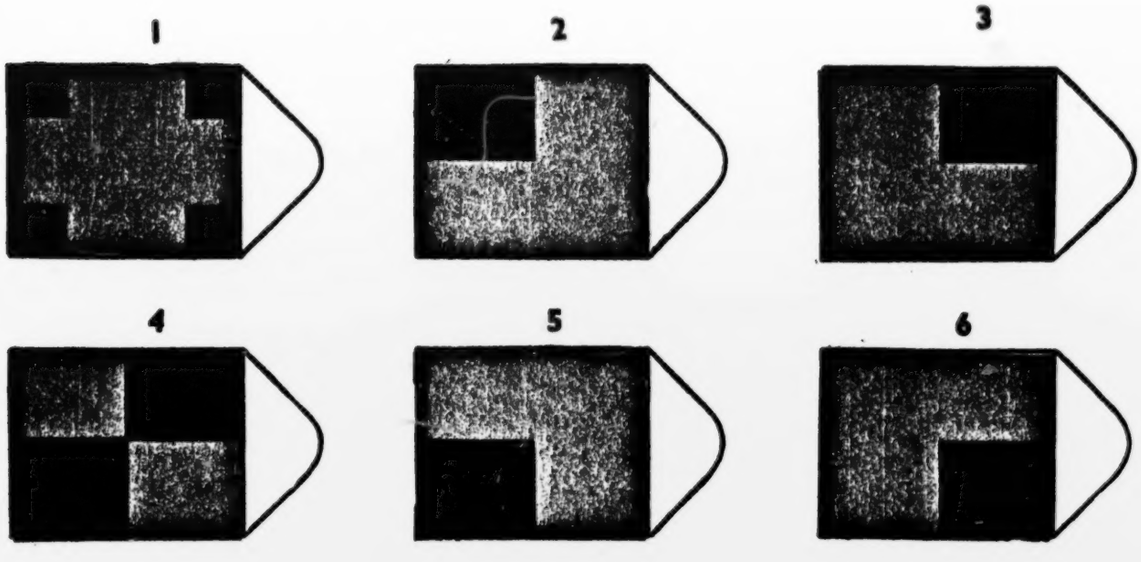


M-20

A

A_B 9

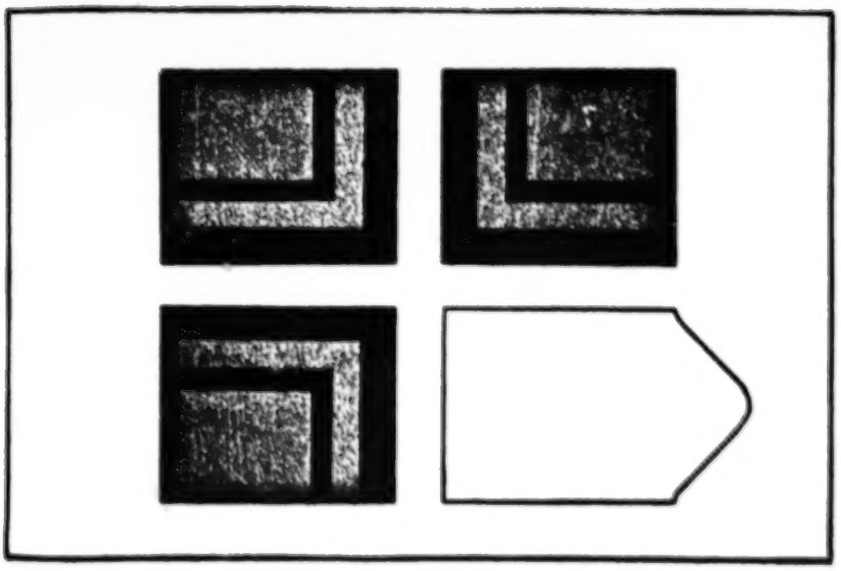


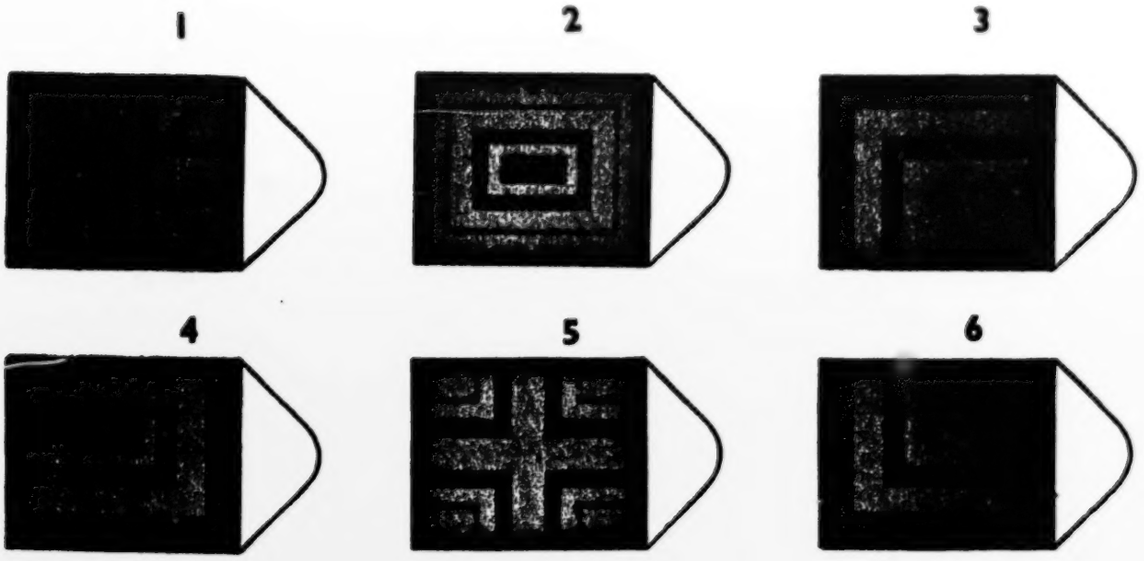


M-21

A

A_B 10

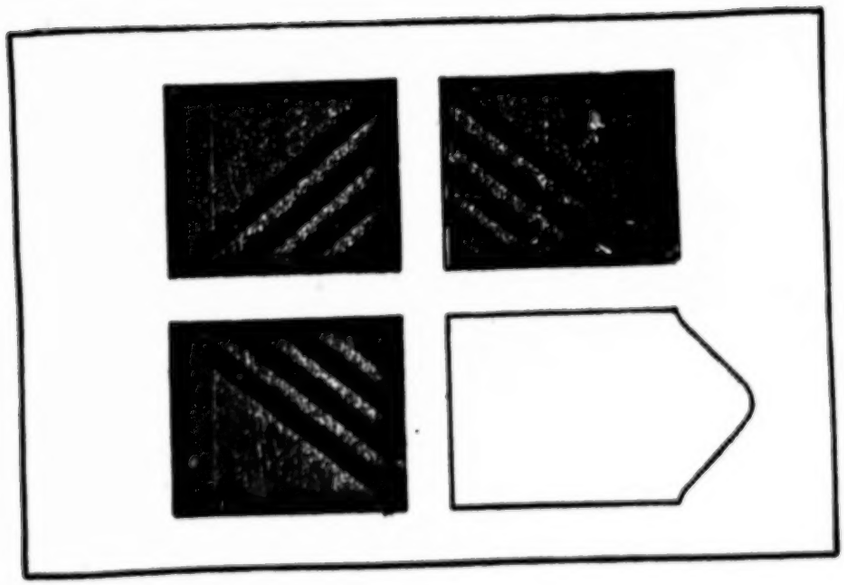


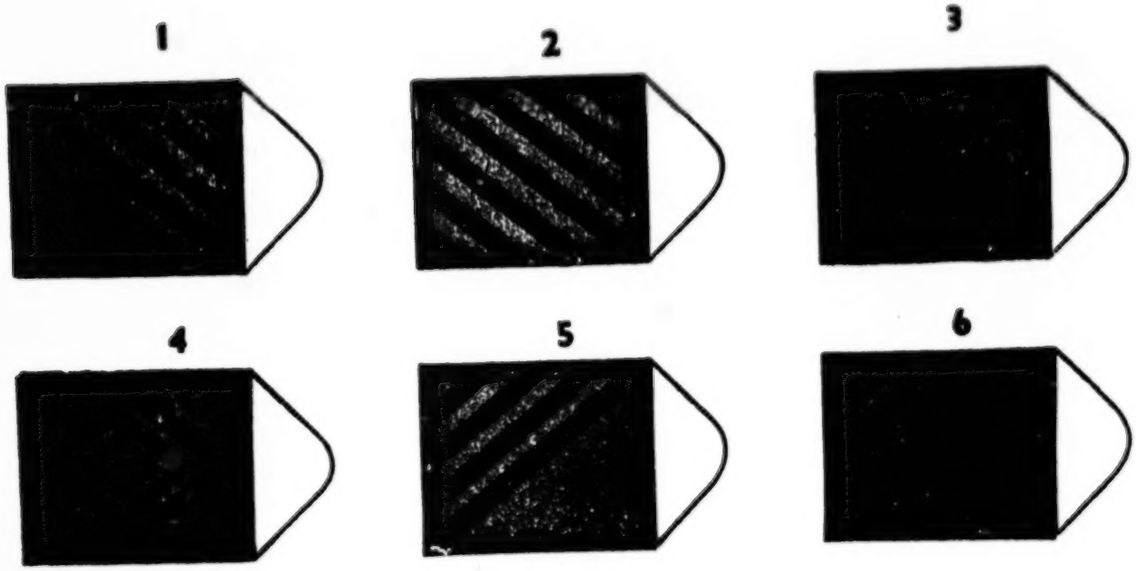


M-22

A

A_B 11

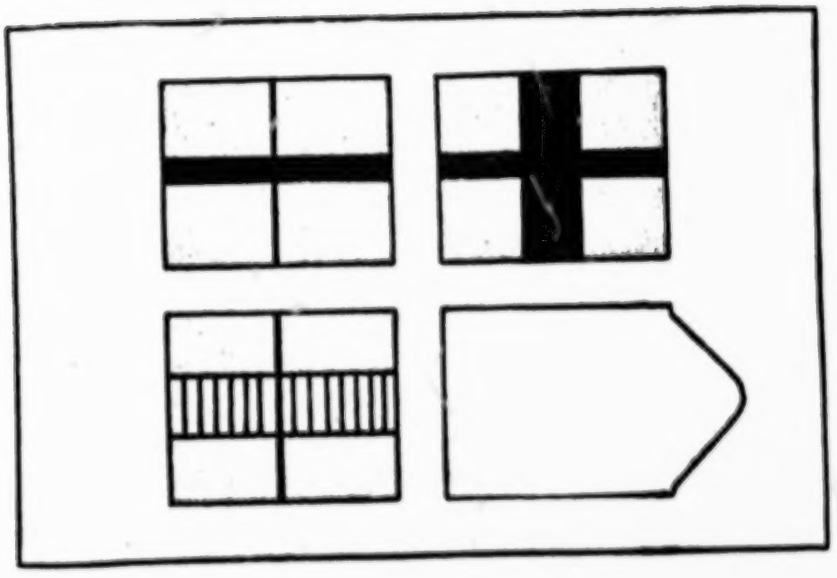


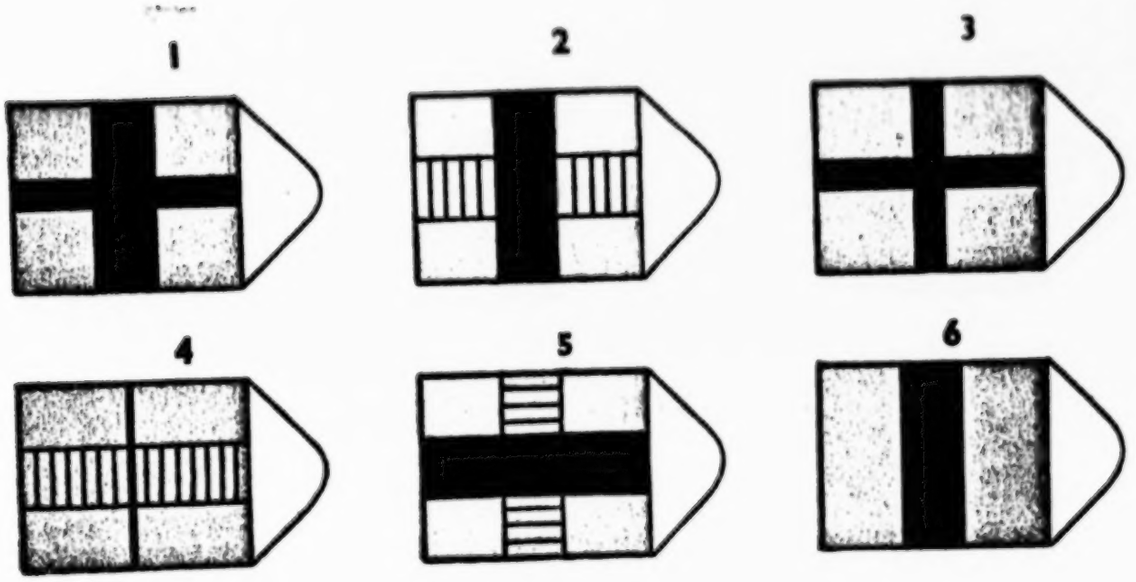


M-23

A

A_B 12

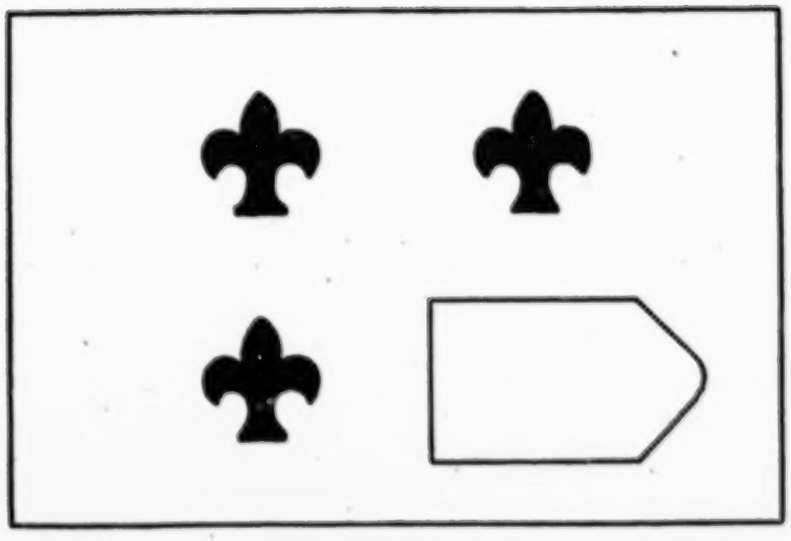


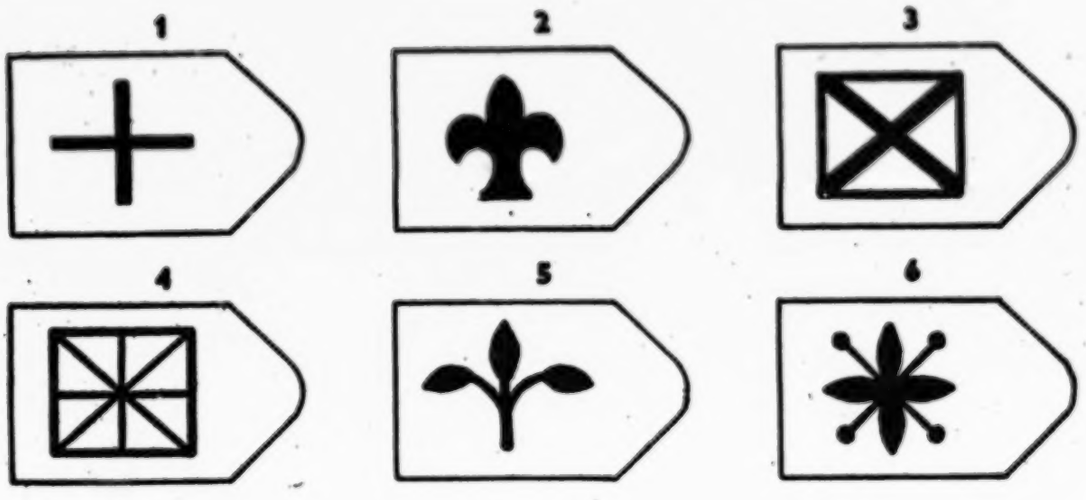


M-24

A

B I

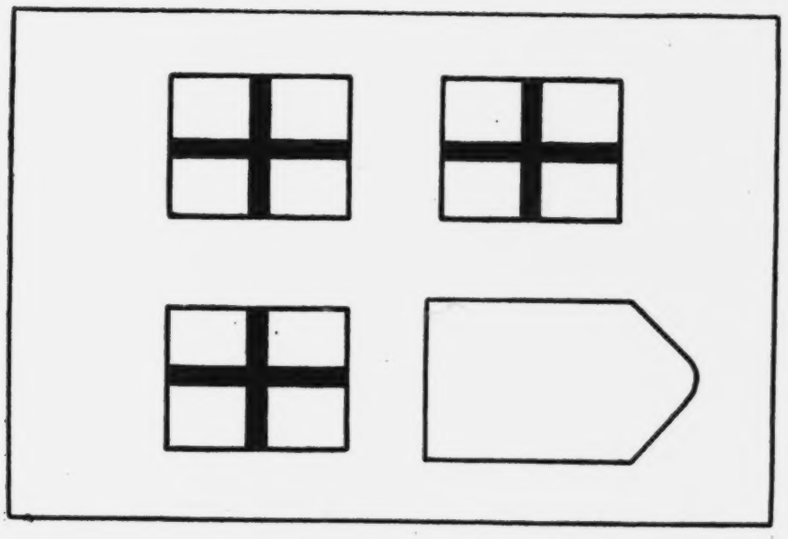


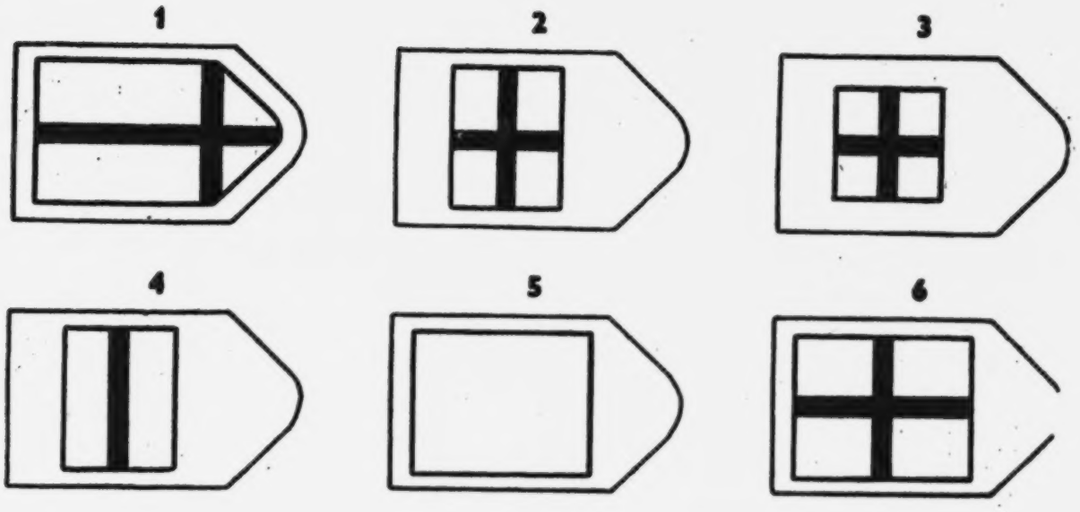


M-25

I

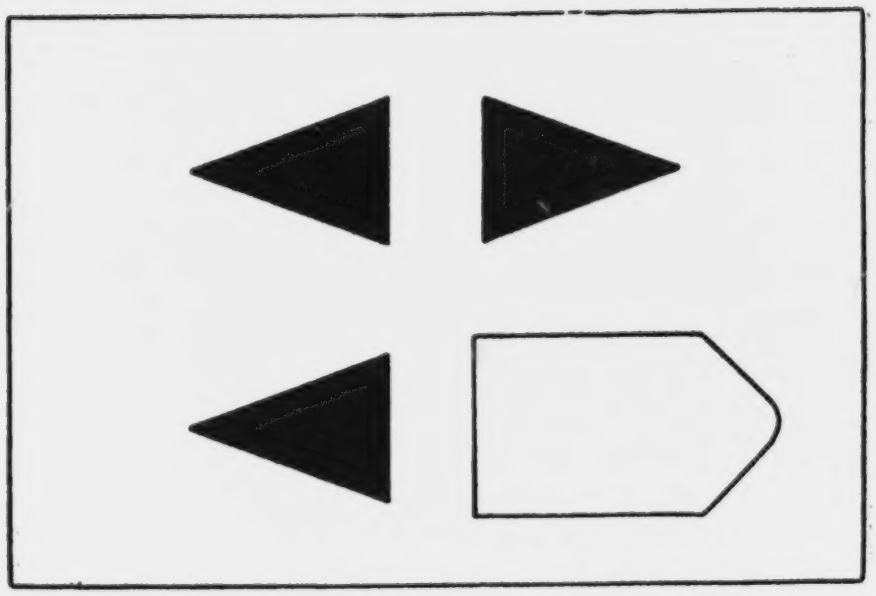
B 2

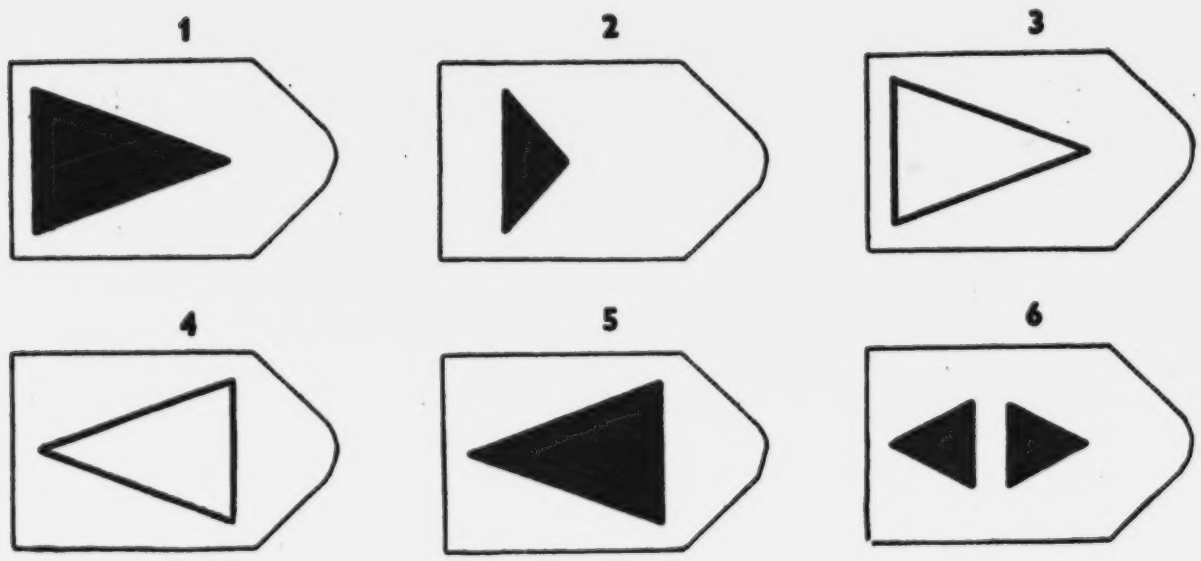




I

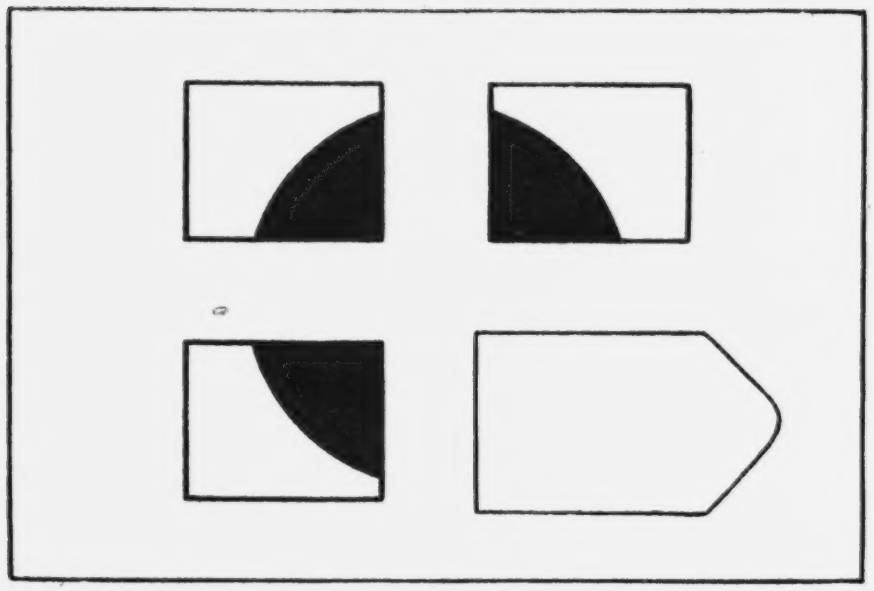
B 3

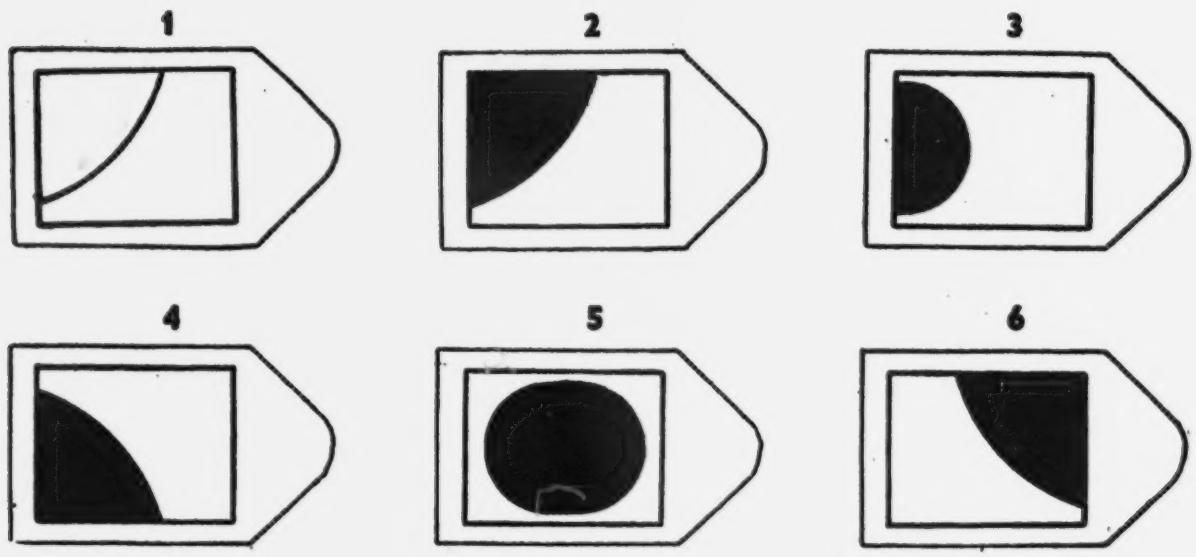




A

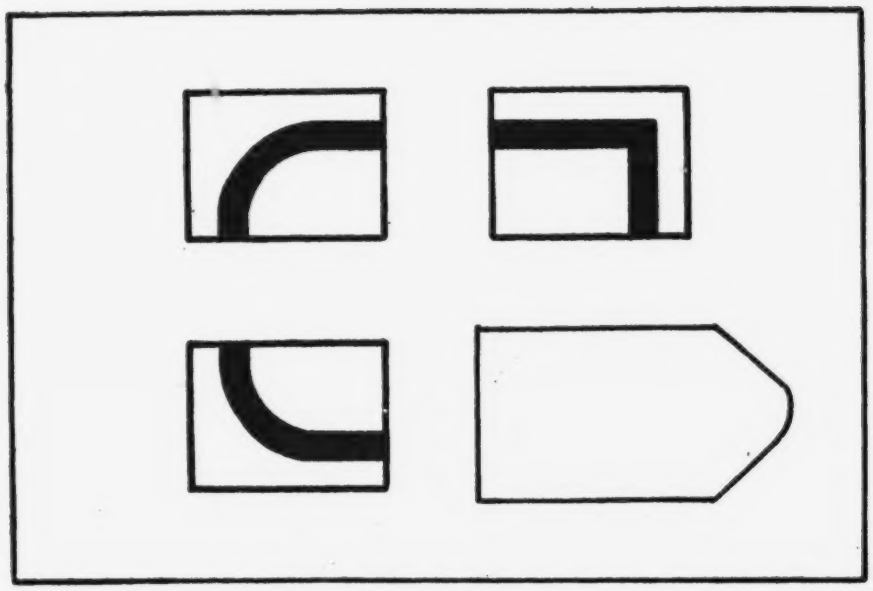
B 4

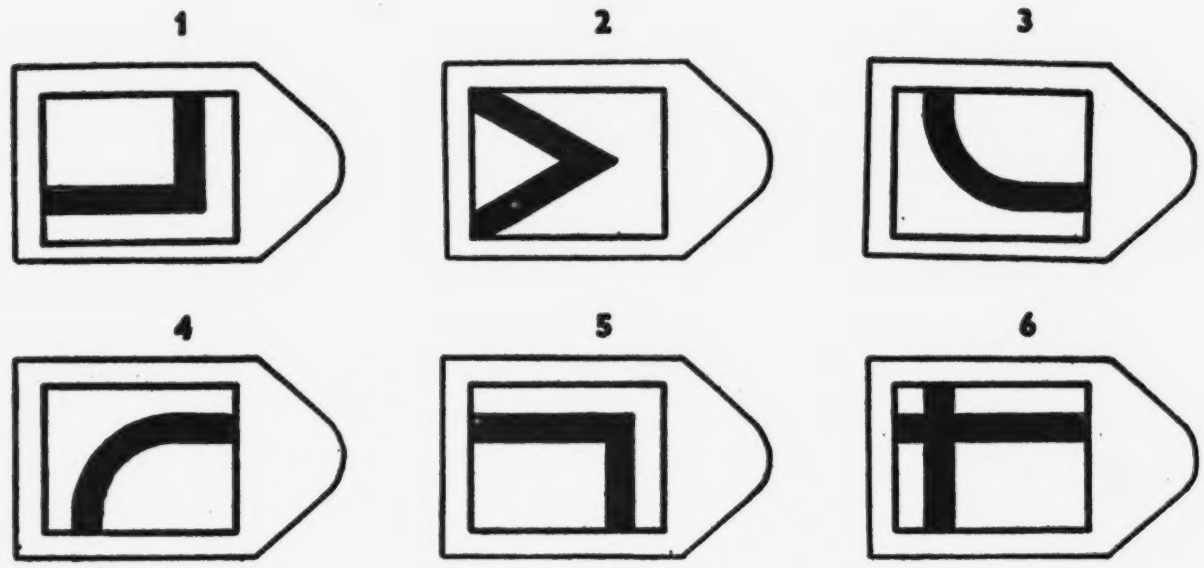




6

B5

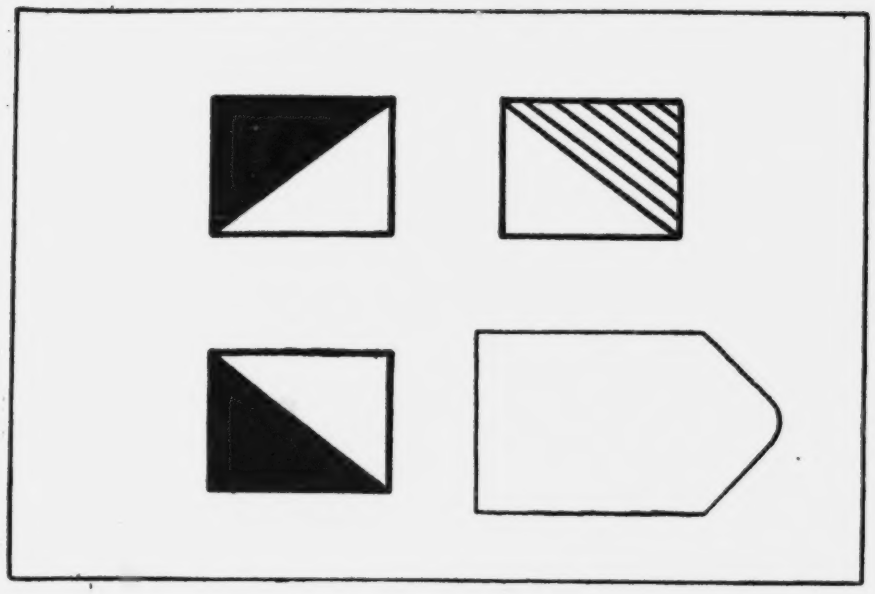


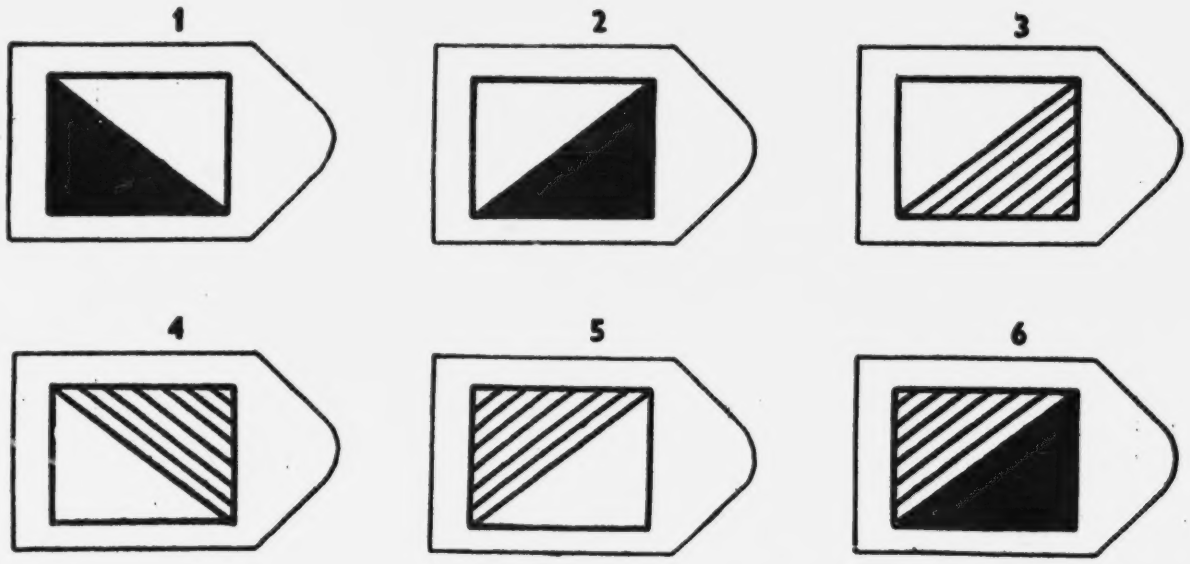


M-29

A

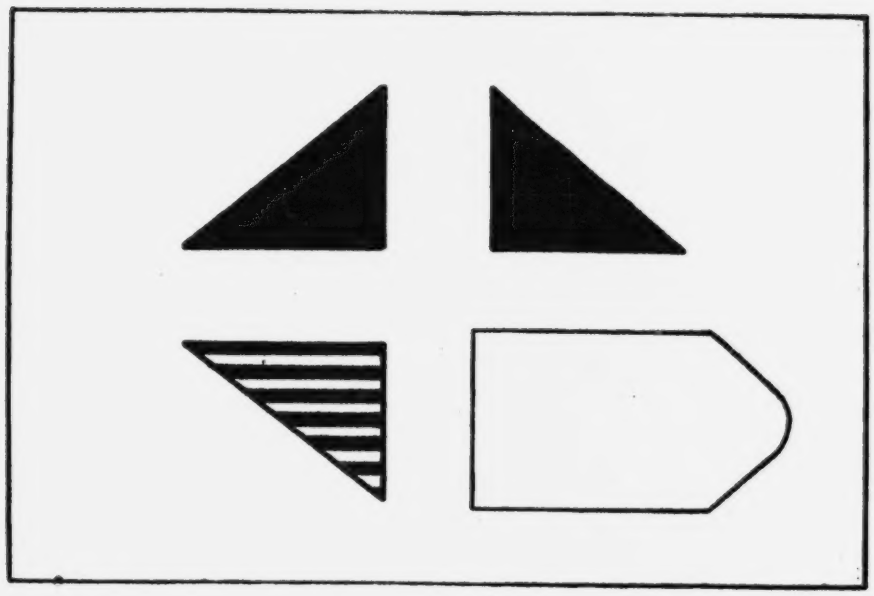
B6

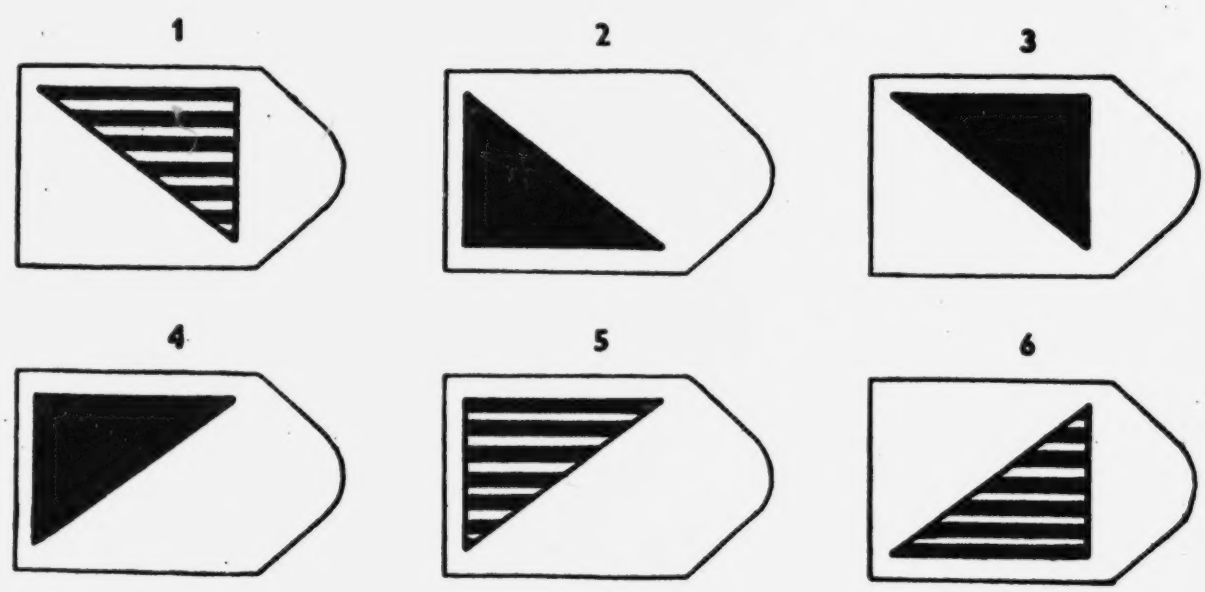




A

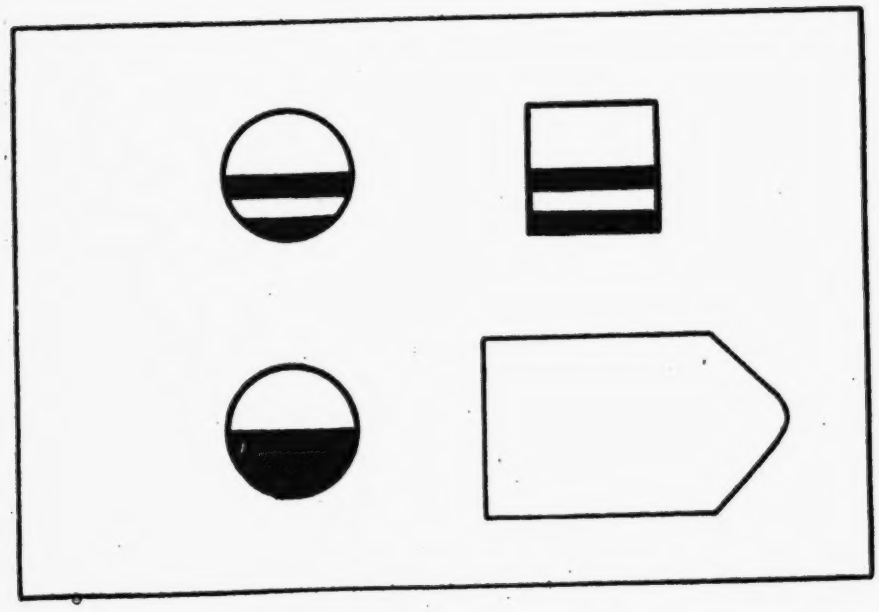
B7

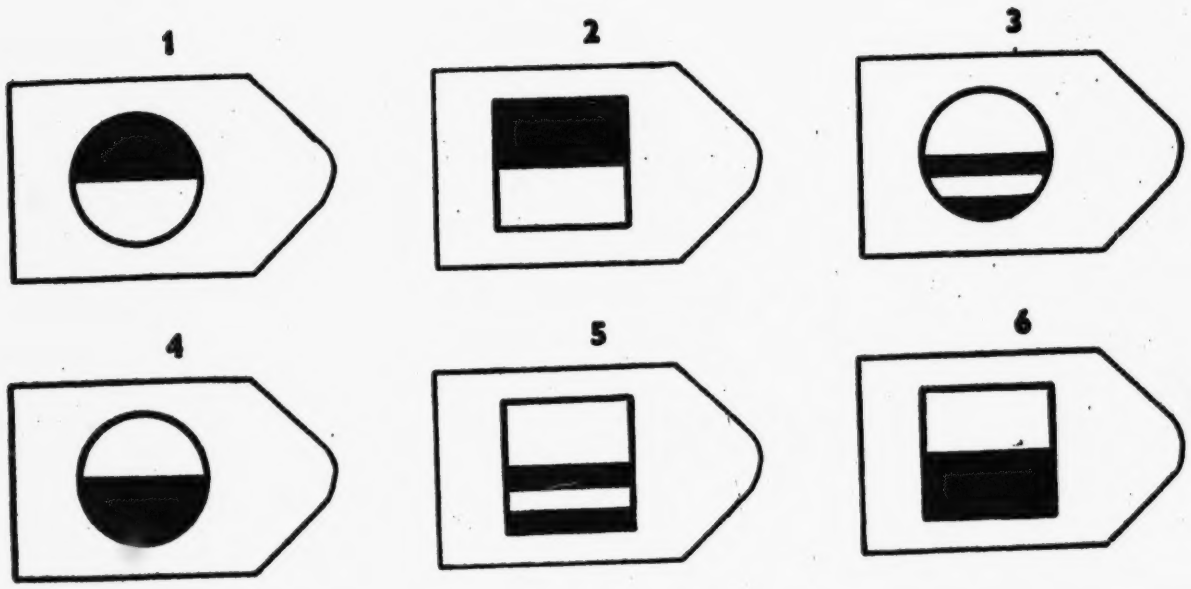




A

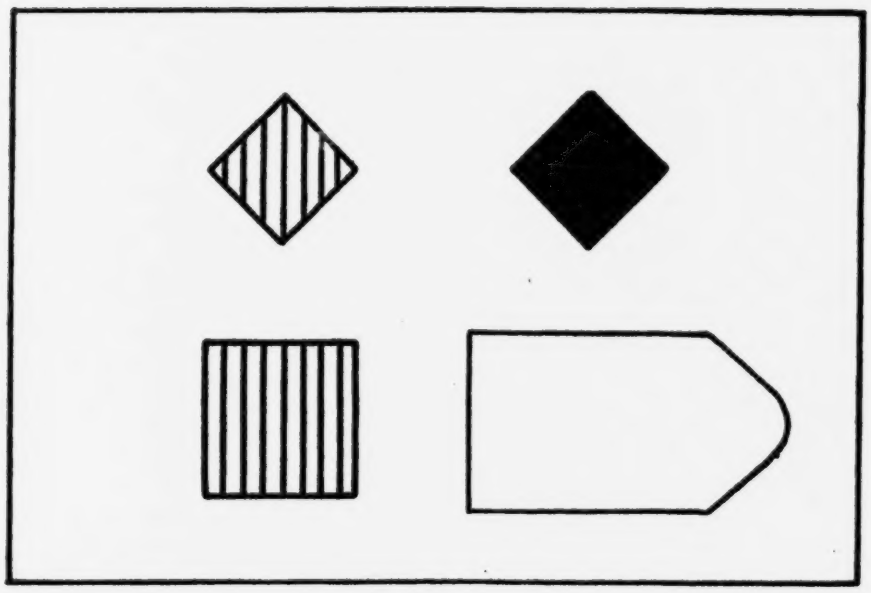
B 8

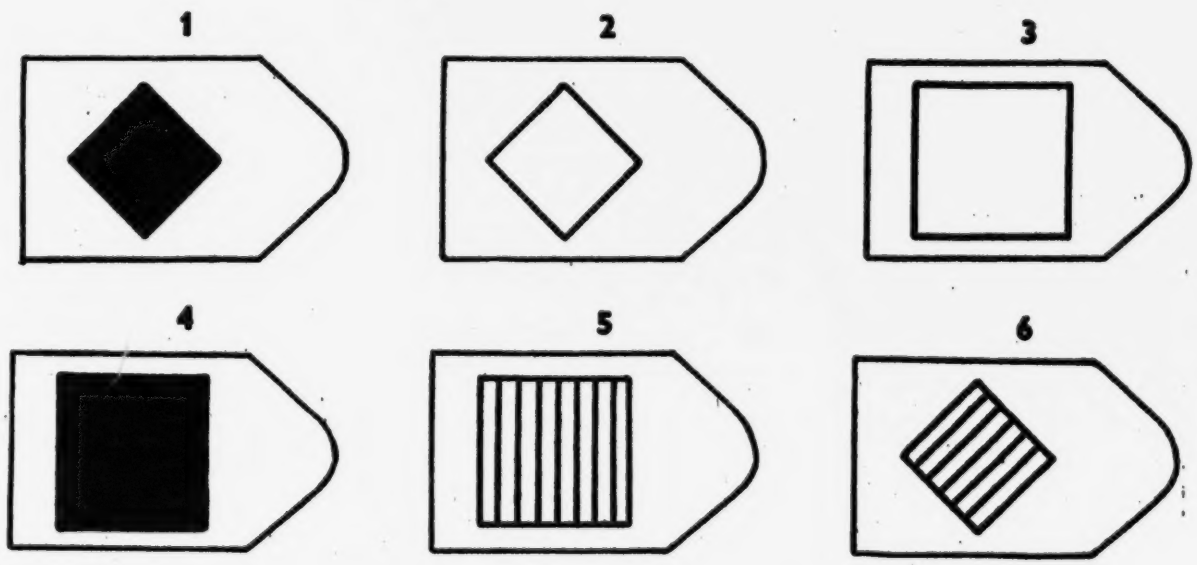




A

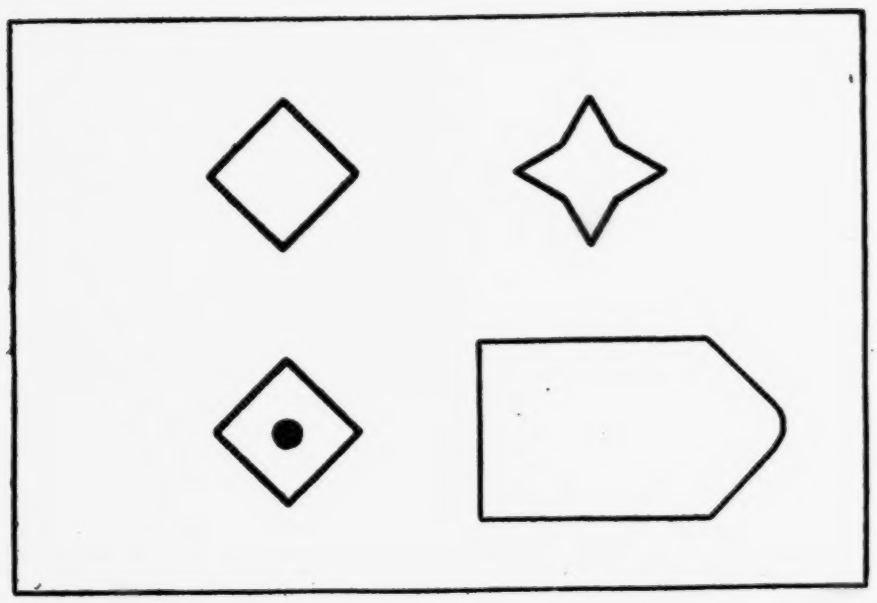
B9

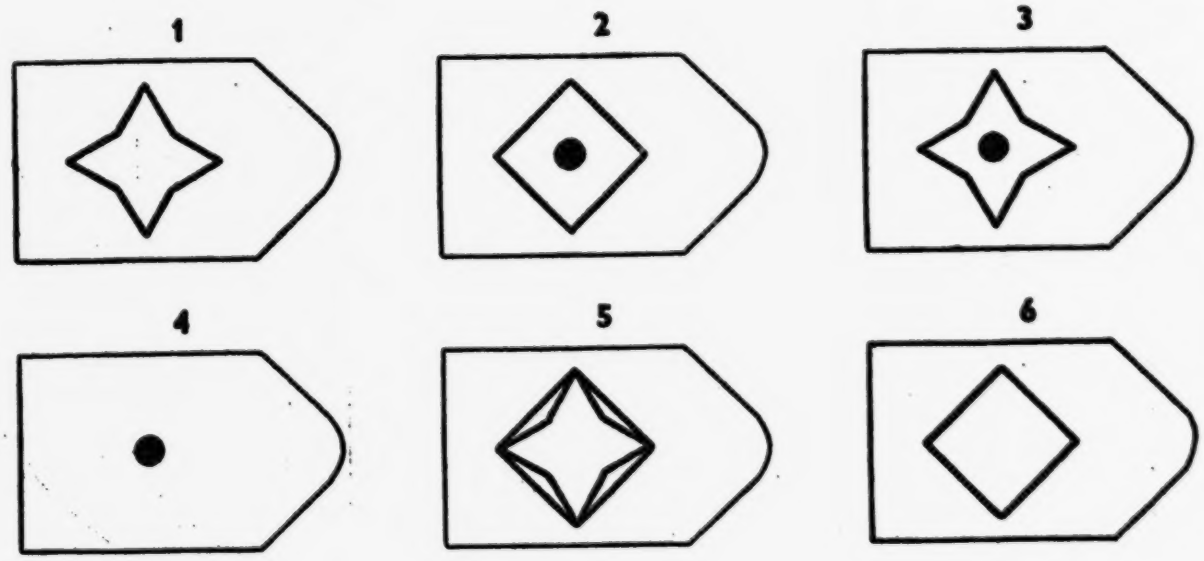




A

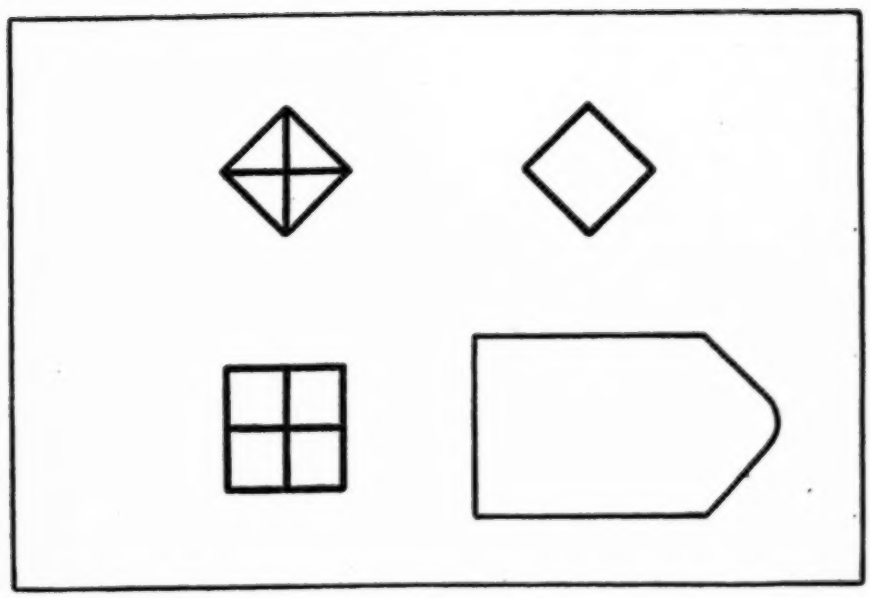
B 10

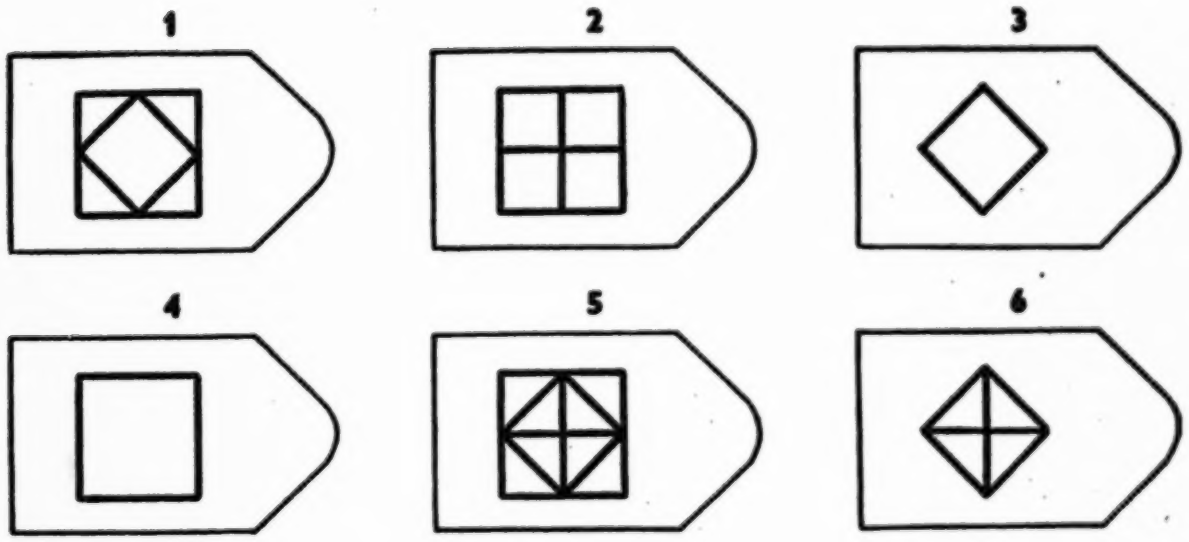




A

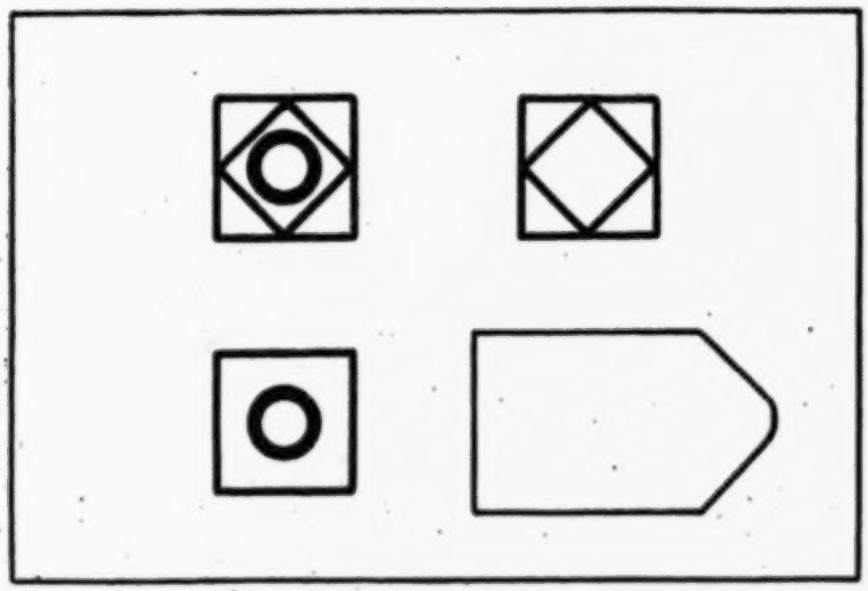
B II

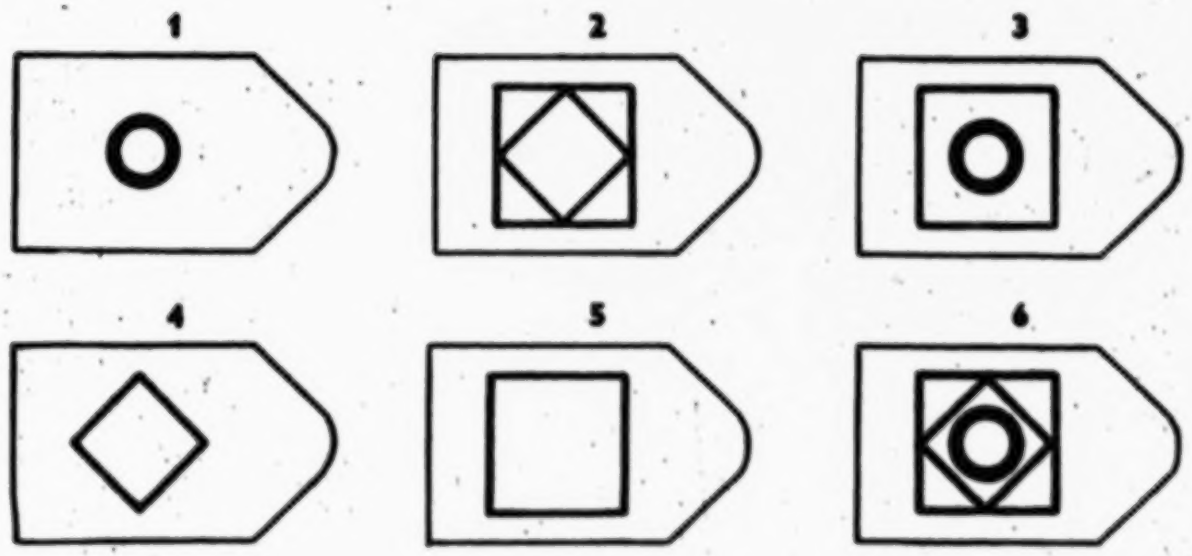




A

B 12





M-36

A